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A REVIEW OF THE MYCTOPHID FISHES OF THE PACIFIC COAST OF THE UNITED STATES AND OF LOWER CALIFORNIA

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The area treated in this report is a semicircular segment of the North Pacific Ocean approximately 1000 miles in radius, having its center a little east of Point Conception, California, and extending from Cape Flattery, Washington, to Cape San Lucas, Lower California, including the Gulf of California.

From this region 20 species of Myctophid fishes are known, including three species herein described as new. Still another species has been listed by C. B. Wilson (1935) who records that the parasitic copepod *Sarcotretes scopeli* was taken from the flesh of the lantern fish *Myctophum glaciale*, from the California coast, by Dr. D. S. Jordan. Dr. Wilson has informed me (*in litt.*) that the copepod was removed from its host and sent to him with a label which stated that it had been taken from *Myctophum glaciale*, and that that is the extent of his knowledge with reference to it. He adds, "I have no means of knowing who identified the host but can easily imagine that it may have been misidentified. I am reasonably sure that the label was not in Dr. Jordan's handwriting, but had been made by someone else." Under these circumstances, I do not feel justified in including in this report a species which has not previously been reported from the Pacific.

I have been able to examine specimens of all of the species treated, 17 of them from the area discussed, while *Myctophum pterotum*, *M. reinhardtii* and *Notoscopelus elongatus* have been available only from other parts of the Pacific.

The nucleus of my material was an excellent collection made incidentally by the California State Division of Fish and Game while pursuing their investigations of commercial fishes. My sincere thanks are due to the Division for presenting me with this collection and for their courtesy in allowing me to collect additional specimens from their patrol and research vessels "Albacore," "Bluefin" and "Yellowtail."

After the investigation was well under way, I was able to make another equally fine collection during the 1938 Crocker-Stanford Expedition on board the "Zaca," and to include this material in the present report. It is a pleasure to express my appreciation to Mr. Templeton Crocker of San Francisco for this privilege. The fishes from both of these sources are deposited in the Natural History Museum of Stanford University.

In addition, I have examined all of the other specimens in the Natural History Museum of Stanford University which are germane to the problem. I am indebted to Dr. F. M. McFarland and Mr. H. W. Clark of the California Academy of Sciences, to Dr. L. P. Schultz of the United States National Museum, and to Mr. W. C. Schroeder of Harvard University, for the loan of much valuable material, and also to Prof. A. E. Parr of Yale University for two specimens of *Lampanyctus idostigma* in exchange.

While many species of lantern fishes may be identified with ease, others, belonging to closely related aggregates of species, present great difficulties. This is in part due to the briefness and inadequacy of many current descriptions. It has, therefore, been my purpose to describe rather fully and to figure each species treated. Since several commonly accepted species may require further subdivision, these descriptions and figures are based entirely on specimens at hand, in an attempt to deal with undoubted systematic units. Metameric and proportional values do not include divergent data given by other authors unless so noted.

Since proportional differences of a very few percent are often significant distinguishing characters, I present a statement as to the method of taking measurements. All measurements were made with a pair of dividers and were recorded in tenths of mm. Measurements of less than 20 mm. were made under a dissecting microscope. The percentages were calculated mathematically. In an attempt to determine the normal limits of variation measurements were made upon 50 specimens if available, otherwise upon all specimens which were in suitable condition. The initial values given in the lists of measurements are the arithmetical means of all specimens measured; the values included in parentheses are the extremes.

The standard length is measured from the tip of the snout to the end of the hypural. The latter point, readily seen in small semi-transparent specimens, may be determined with fair accuracy in larger individuals by bending the caudal fin from side to side and noting the position of the abrupt wrinkle formed at the base of the rays. The length of the head is measured from the tip of the snout to the extreme posterior margin of the opercular flap. The diameter of the orbit is the horizontal distance between opposite margins of the socket. The length of the maxillary is measured from the tip of the upper jaw to the posterior end of the maxillary. The distance from dorsal to ventral is measured from the base of the first dorsal ray to the base of the first ventral ray; the distance from dorsal to anal, from the same point to the base of the first anal ray. The first of these measurements often deviates from the perpendicular, the second is always strongly oblique. They were selected in an attempt to present some indication of the body depth at fixed points marked by skeletal features, instead of using the usual "greatest depth" which, although strictly vertical, may be taken at various places in different specimens depending upon the state of the gonads or digestive tract. The depth of the caudal peduncle is its least vertical depth.

The distances from the snout to the various fins are measured from the tip of the snout to the bases of the anterior dorsal and anal rays, the upper pectoral ray and the outer ventral ray. In the descriptions the locations of fin insertions are given in such terms as, "ventral base midway between pectoral base and dorsal origin." In these cases it is to be understood that the base of the outer ventral ray is midway between the *vertical of* the upper pectoral ray and the *vertical of* the first dorsal ray. Similarly photophores said to be "above" other organs are merely above the *level of* these organs unless definitely stated to be directly above them. The lengths of the dorsal and anal bases are measured from the anterior edge of the first ray to the posterior edge of the last ray.

The terminology and abbreviations established by Brauer (1906) for most of the groups of photophores are used throughout this work. I have also accepted the additional ones introduced by Tåning (1928) and have found it advisable to add to the list as follows:

Suo = Supraorbital organ, Macula supraorbitalis.
Bu = Buccal organ, Macula buccae.
Ce = Cervical organ, Macula cervicis.

The general position of the various organs is indicated on the diagram of a hypothetical Myctophid in which all of the photophores are present (fig. 1). Additional luminous glands are encountered in a few species but no definite terminology has been applied to these.

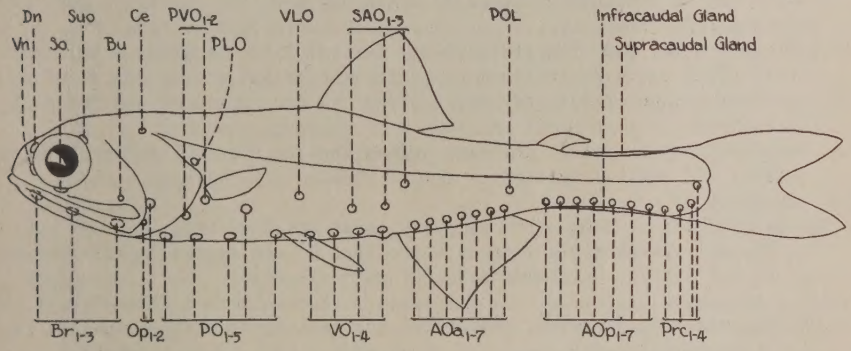

Fig. 1. A hypothetical Myctophid showing the general distribution and terminology of the photophores.

Family MYCTOPHIDAE

Scopelini Müller, 1843, p. 321.
Scopelidae Owen, 1846, p. 48 (*fide* Girard 1858).
Myctophidae Gill, 1893, p. 131.

Caudal fin well developed, free from anal. Pectorals lateral. Pelvics 6-11 rayed, located well behind pectorals. Palatine normal, its anterior end attached to vomer, with a process directed upward and outward, overlapping proximal end of maxillary and supported by a lateral projection of the mesethmoid. Ethmoid with a median keel. Parasphenoid extending upward to frontals between lateral ethmoids. Interopercle not reduced. Cleithrum attached to lower end of supracleithrum.

Although I am by no means satisfied by current definitions of this family, I tentatively accept the delimitation of Regan (1911) and the subsequent division

into subfamilies proposed by Parr (1928) as representing the most satisfactory classification yet devised. Improvements must await opportunity for further osteological and other anatomical investigations on several rare species.

ARTIFICIAL KEY TO THE SPECIES

1a. Photophores absent; eye small, orbit contained more than 8 times in head ..... *Scopelengys tristis*, p. 94.

1b. Photophores present, occurring in definite series; orbit contained less than 6 times in head.

2a. AO in a continuous series; no Pol..... *Electrona crockeri*, p. 98.

2b. AO in 2 series separated by an interspace; Pol present.

3a. PLO below upper end of pectoral base; lateral line very short, pores on only a few of the anterior scales; 6 (rarely 5-8) PO; 6 (rarely 5-7) VO; only a single Prc..... *Tarletonbeania crenularis*, p. 101.

3b. PLO above upper end of pectoral base; lateral line complete; 5 PO, the fourth often elevated to level of pectoral base and widely removed from the other organs of this series; 3-5 VO; 2-5 Prc sometimes continuous with AOp series.

4a. Fourth PO not elevated, all five organs forming a definite line between isthmus and ventral base.

5a. Only 1 Pol.

6a. SAO angulated, SAO_1 on or slightly above level of SAO_2

7a. VO_2 not elevated, in line with the rest of the organs in this series; AO 6-7 + 8-10; Op_2 below level of pectoral base ..... *Myctophum californiense*, p. 106.

7b. VO_2 markedly elevated, well above the rest of the organs in this series; AO 5-7 + 3-5; Op_2 very high, above level of pectoral base ..... *Myctophum pterotum*, p. 116.

6b. SAO forming a straight line or very gentle curve, SAO_1 markedly lower than SAO_2.

8a. VO_2 not elevated, about on a line with the other organs in this series (best noted from ventral view); pectorals not reaching anal origin.

9a. Anal 19-21; orbit 10.1-11.5% of standard length; maxillary 18.1-20.2%; dorsal to ventral 21.0-26.0%; dorsal to anal 25.0-28.5% ..... *Myctophum affine*, p. 110.

9b. Anal 23-25; orbit 7.9-8.7% of standard length; maxillary 16.0-17.4%; dorsal to ventral 16.1-18.1%; dorsal to anal 21.0-23.7% ..... *Myctophum aurolaternatum*, p. 108.

8b. VO_2 elevated, definitely above a line connecting VO_1 and VO_3; pectorals extending beyond anal origin.

10a. VLO forming a straight line with the 2 PVO; Prc_1 and Prc_2 separated by a space much smaller than that between last AOp and Prc_1; base of pectoral more nearly vertical than horizontal ..... *Diogenichthys laternatus*, p. 119.

10b. VO_2 forming a straight line with the 2 PVO; Prc_1 and Prc_2 separated by a space about equal to that between last AOp and Prc_1; base of pectoral more nearly horizontal than vertical ..... *Diogenichthys scofieldi*, p. 122.

5b. Two or 3 Pol.
11a. PVO_2 well below upper end of pectoral base; Pol_1 conspicuously lower than Pol_2; pectoral fin extending about to anus.
12a. PLO midway between lateral line and pectoral base or slightly lower; SAO strongly angulated, SAO_1 about on same level as SAO_2 and anterior to VO_3; 2 Prc.....*Myctophum reinhardtii*, p. 113.
12b. PLO much nearer lateral line than pectoral base; SAO slightly curved, SAO_1 well below SAO_2 and posterior to VO_4; 4 Prc .....*Lampanyctus townsendi*, p. 147.
11b. PVO_2 well above upper end of pectoral base; the 2 Pol on about the same level; pectoral fin not extending beyond ventral base .....*Notoscopelus elongatus*, p. 151.
4b. PO_4 markedly elevated, often to level of pectoral base.
13a. PLO markedly nearer pectoral base than lateral line; a very large and prominent Dn; no luminous glands on caudal peduncle .....*Diaphus rafinesquii*, p. 125.
13b. PLO markedly nearer lateral line than pectoral base; no Dn developed; both supra- and infracaudal luminous glands present.
14a. VLO in or slightly above lateral line; PVO_1 markedly anterior to PVO_2; VO_2 elevated and advanced to a position above ventral base and well in front of VO_1; VO_3 also markedly elevated, these 2 organs far above a line connecting the other 3 organs in the series .....*Lampanyctus mexicanus*, p. 135.
14b. VLO well below lateral line; PVO_1 directly under or slightly posterior to PVO_2; all of the VO in line or very slightly elevated.
15a. Only 1 Pol; SAO_1 behind last VO; Ce absent.
16a. Maxillary extending only about 1.0 to 1.2 orbital diameters behind eye (measured parallel to maxillary); supracaudal gland extending forward much more than half way to adipose fin; infracaudal gland originating opposite AOp_1 or AOp_2; 4 (rarely 3 or 5) VO; 4 (rarely 3 or 5) Prc.....*Lampanyctus leucopsarus*, p. 129.
16b. Maxillary extending more than 1.5 orbital diameters behind eye; supracaudal gland extending not more than half way to adipose fin; infracaudal gland originating opposite AOp_3 or AOp_4; 5 (rarely 4) VO; 3 (rarely 4) Prc.....*Lampanyctus nannochir*, p. 133.
15b. Two Pol; SAO_1 in front of last VO; Ce present but often very difficult to distinguish.
17a. Pectoral fin long, extending about to anal origin; AOp_1 well behind base of last anal ray.....*Lampanyctus steinbecki*, p. 140.
17b. Pectoral fin short, extending about to ventral base; AOp_1 over or very little behind base of last anal ray.
18a. Infracaudal gland short, originating about opposite next to last AOp; AO 5-6 + 5-7; no Bu.....*Lampanyctus idostigma*, p. 138.
18b. Infracaudal gland long, originating about opposite AOp_2 or AOp_3; AO 6-7 + 7-8; Bu present.
19a. VLO about midway between lateral line and ventral base, forming a straight line with SAO_1 and SAO_2.....*Lampanyctus ritteri*, p. 141.
19b. VLO much nearer lateral line than ventral base, far above a line passing through SAO_1 and SAO_2.....*Lampanyctus regalis*, p. 144.

Subfamily SCOPELENGINAE

Scopelengini Parr, 1928, p. 48.

No photophores developed. Pseudobranchiae rudimentary. This subfamily contains but a single known genus and species.

Genus *SCOPELENGYS* Alcock

Scopelengys Alcock, 1890b, p. 302 (genotype by monotypy *Scopelengys tristis* Alcock).

Scopelengys tristis Alcock

Scopelengys tristis Alcock, 1890b, p. 303 (Investigator station 104, off the Elicapeni Bank in the Laccadive Sea); 1892, pl. 7, fig. 7.
Scopelengys dispar Garman, 1899, p. 254, pl. 54, figs. 2-2d (Albatross stations 3353, 3360, 3382 and 3383, off the Pacific coast of Panama).
Scopelengys lugubris Garman, 1899, p. 400 (*lapsus calami pro Scopelengys dispar*).

Body moderately slender, elongate; deepest at posterior end of head; tapering rather evenly from this point to caudal peduncle. My figure is drawn from a specimen in poor condition with the abdominal region shrunken and concave instead of expanded as shown by Alcock and by Garman. Upper anterior profile concave. Snout truncated. Lower jaw slightly projecting. Mouth large. Maxillary

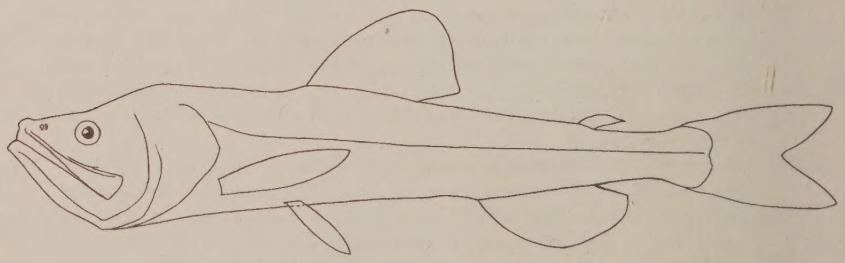

Fig. 2. *Scopelengys tristis* Alcock

evenly but widely expanded, its posterior width greater than diameter of orbit; extending far beyond eye, about 0.4 of its length lying behind a perpendicular to the mouth drawn through posterior margin of orbit. Broad bands of villiform teeth on premaxillaries and dentaries. Vomer with an oval patch of villiform teeth on each side, the median line naked. Palatines with long narrow bands of similar

teeth. Eye very small, diameter of orbit about 2.5 in snout, 8.8 in head.

Fin formula, including Alcock's and Garman's values: D. 11 (11-12); A. 13 (11-13); P. 16 (15-16); V. 8. I fully agree with Parr (1928) that the differences in the number of fin rays between *Scopelengys dispar* and *S. tristis* recorded by Garman (1899) are too insignificant to justify specific separation, particularly since a specimen from Lower California with 13 anal rays leaves a difference of only 1 dorsal ray as the distinguishing character. Dorsal origin about midway between snout and end of anal base; dorsal base about 1.2 in anal base. Anal origin somewhat more than peduncular depth behind dorsal. Adipose about over end of anal base. Pectoral base slightly posterior to a point midway between snout and end of dorsal; fin extending about to middle of dorsal base. Ventral base about 3 times as close to dorsal origin as to pectoral base; fin extending slightly farther than pectoral but not half way to anal origin. Color jet black.

Measurements in percent of standard length, based on a single specimen: length of head 31.5; diameter of orbit 3.6; length of maxillary 18.0; distance from dorsal to ventral 17.4; distance from dorsal to anal 29.8; depth of caudal peduncle 7.1; distance from snout to dorsal 44.7; length of dorsal base 15.0; distance from snout to anal 68.7; length of anal base 17.7; distance from snout to adipose 83.2; distance from snout to pectoral 30.9; distance from snout to ventral 41.3.

Of this species I have examined only one specimen in poor condition. It is United States National Museum No. 87561, 124.7 mm. in standard length, from off Breaker Point, Lower California, Lat. 27° 39' 15" N., Long. 115° 16' 00" W. Originally described from the Indian Ocean, *Scopelengys tristis* has since been taken at six western American stations between central Lower California (station noted above) and the Bay of Panama, Lat. 7° 21' 00" N., Long. 79° 02' 00" W.

Subfamily MYCTOPHINAE

Myctophini Parr, 1928, p. 49.

Photophores developed, limited to definite and separate series; 3 Br organs always present; pseudobranchiae well developed.

Most current authors group the species of this subfamily into the four genera *Myctophum, Lampanyctus, Diaphus* and *Lampadena*. A few others tend to follow Goode and Bean in splitting the group into numerous smaller genera. While our present knowledge of these fishes is so inadequate as to make very extensive splitting seem premature, certain individual species or small aggregates of species appear, on the evidence of prominent external characters, to be so widely separated from their nearest relatives that their inclusion in one or the other of the four large genera seems too conservative. These large genera have been established practically entirely on the basis of the luminous organs. I submit, however, that the evolution has modified other bodily features as well, and that the importance of these should be recognized. While too ardent splitting may not be advisable, the retention of only four genera does not permit us to depict several important and easily recognizable lines of evolution.

In order to facilitate an estimation of the systematic position of the fishes discussed, I have deemed it advisable to present a diagram (fig. 3) of the interrelationships of those fishes which are commonly placed in the genus *Myctophum*. This diagram is tentative and will undoubtedly require drastic revision as

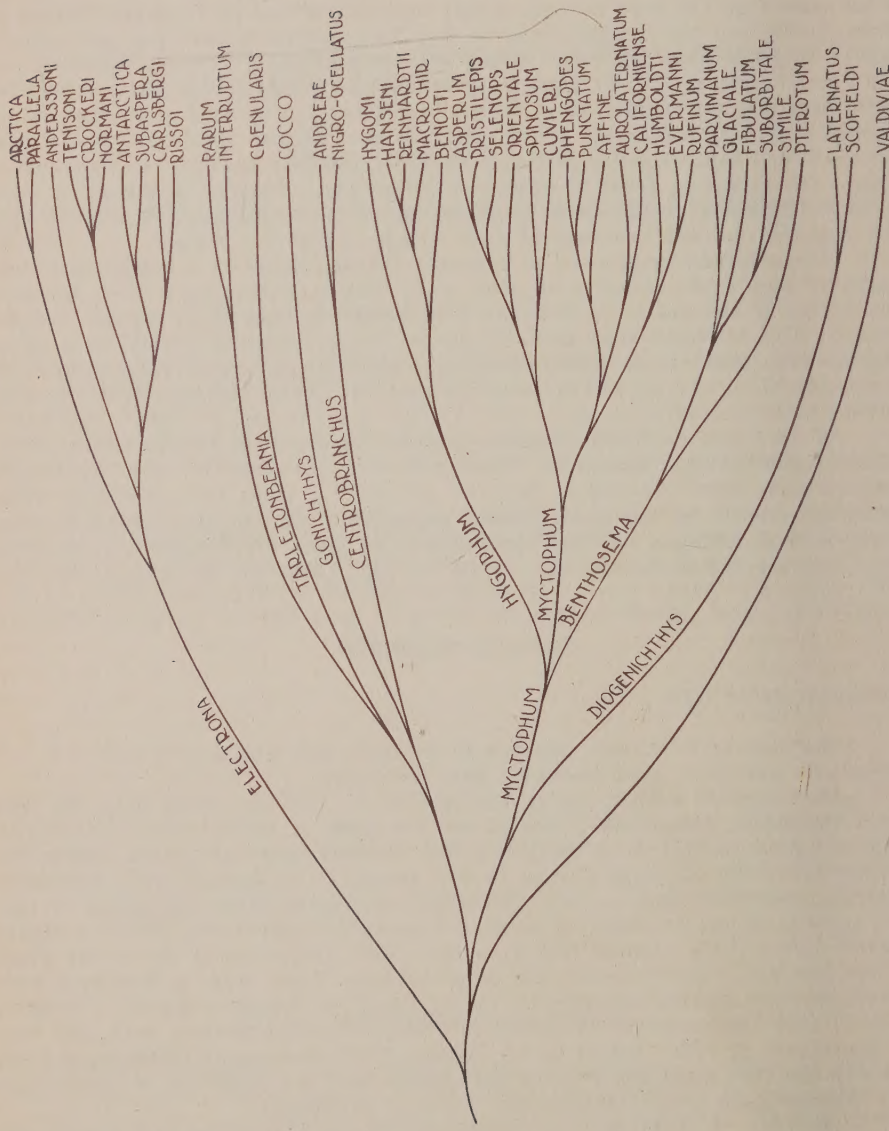

Fig. 3. Tentative diagram of the interrelationships of the fishes which have usually been placed in the genus *Myctophum*.

additional information becomes available. Several species of uncertain validity, such as *Myctophum hollandi* Jordan and Jordan and *Benthosema pinchoti* Fowler, both of which are probably based on specimens of *Myctophum fibulatum*, have been omitted since the chief purpose of the diagram is to represent the main lines of evolution.

Genus *ELECTRONA* Goode and Bean

Electrona Goode and Bean, 1895, p. 91 (genotype by original designation *Scopelus rissoi* Cocco).

Maxillary broadly and evenly expanded posteriorly. Gill-rakers well developed, long. Dorsal base much shorter than anal base. No photophores above lateral line; PLO well below upper end of pectoral base, appearing as a third PVO; 5 PO and 4 VO, all on same level; AO in a continuous series; Pol absent; 2 Prc, the second scarcely elevated if at all.

As outlined above, the genus *Electrona* contains 10 known species which are easily distinguished from all other forms by the continuous AO series of photophores and by the absence of the Pol. The unbroken serial arrangement of the AO series is probably primitive, as is also the low position of the PLO and SAO_3, which in some of the species form, together with the PVO series, the VLO and the first two SAO, an almost straight horizontal line. These features suggest the derivation of the modern Myctophinae from an ancestor with 2 ventrally located, parallel series of photophores, such as we find in *Vinciguerria*.

Unique features in the arrangement of the luminescent organs, together with other characters not restricted to this group but characteristic of all of its members, such as the broadly expanded maxillary, the comparatively limited gape of the mouth and the occurrence of 2 Prc on the same level, indicate that the genus comprises a well defined systematic group of reasonably closely related forms. The assumption that the photophore arrangement is primitive leads us to the conclusion that this group represents a phylogenetic unit which split off very early from the main line of development represented by all of the other species of Myctophinae and characterized by markedly elevated luminescent organs that disrupt the primitive pattern. That the split in the ancestral stock took place early, is further indicated by the fact that 10 well differentiated species have evolved within the limits of the genus, and more strongly by the fact that such marked modifications as telescopic eyes have had time to develop in some of the forms.

Considering the relationships of the various species within the genus we find that *Electrona tenisoni* (Norman), *E. crockeri*, new species, and *E. normani* (Tåning) constitute the most primitive group of species, having the two PVO and the PLO approximately in a straight horizontal line and the three SAO similarly arranged. From the ancestors of these species, the two closely related forms *E. parallela* (Lönnberg) and *E. arctica* (Lütken) were probably derived at an early time, retaining a primitive arrangement of the photophores but developing telescopic eyes. This same stock apparently gave rise to the isolated species *E. anderssoni* (Lönnberg) which differs strongly from its relatives in the reduction of the usually conservative series of SAO photophores. The remaining four species, characterized by a triangular instead of a linear arrangement of the photophores in front of the pectoral base and by the elevation of the SAO_3, fall into

two minor sub-groups. *E. rissoi* (Cocco) is somewhat isolated by its unusually short and heavy body but is linked to *E. carlsbergi* (Tåning) by the fact that both supra- and infracaudal luminous plates are developed in the male. This character serves to differentiate these species from *E. antarctica* (Günther) and *E. subaspera* (Günther), in which forms only the supracaudal plates are developed in the male.

Electrona crockeri, new species

Body moderately robust, tapering evenly from the nape to heavy caudal peduncle. Upper anterior profile strongly and evenly rounded; snout pointed, truncate at extreme tip; mouth terminal; lower jaw very slightly protruding. Maxillary broadly expanded and truncate posteriorly, with the upper angle slightly posterior to the lower, its width equal to about 0.6 diameter of pupil; extending very slightly beyond orbit, only about 0.2 of its length behind a perpendicular to mouth drawn through posterior margin of orbit. Eye large, orbital diameter about 2.2 times length of snout. Opercular margin ending in a broadly rounded lobe. Gill-rakers long and slender, those at angle equal to about 0.6 diameter of orbit; 5 + 1 + 16 on first arch.

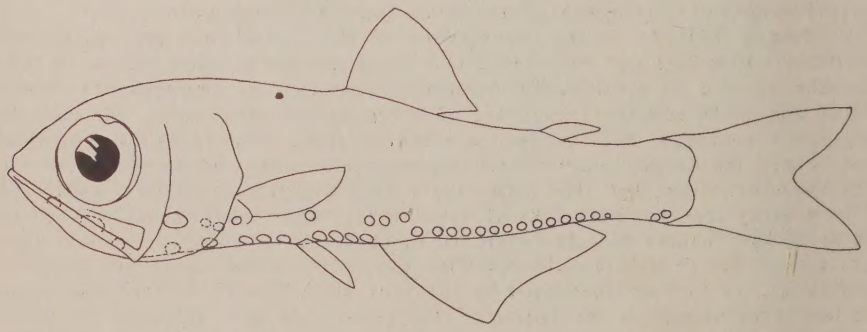

Fig. 4. *Electrona crockeri*, new species.

Fin formula: D. 11; A. 21; P. 15; V. 8. Dorsal origin about midway between snout and Prc_2; dorsal base 2.3 in anal base. Anal origin under anterior half of dorsal (about under fifth ray). Adipose slightly anterior to end of anal base. Pectoral base about midway between snout and AO_3, fin extending about to VO_3. Ventral base about midway between pectoral base and dorsal origin; fin extending almost to anal origin. Scales cycloid, only a very few remaining on the type.

Measurements of type in mm. and percent of standard length (figures in parentheses are percent of standard length): length of head 5.1 (34.7); diameter

of orbit 1.9 (12.9); length of maxillary 3.2 (21.8); distance from dorsal to ventral 3.5 (23.8); distance from dorsal to anal 3.5 (23.8); depth of caudal peduncle 1.7 (11.6); distance from snout to dorsal 7.5 (51.0); length of dorsal base 1.9 (12.9); distance from snout to anal 8.2 (55.8); length of anal base 4.3 (29.3); distance from snout to adipose 11.6 (78.9); distance from snout to pectoral 4.8 (32.7); distance from snout to ventral 6.4 (43.5).

Photophores very large, each with a slightly curved, horizontal, black septum similar to that found in the genus *Diaphus* but not so definitely developed. No trace of any photophores around the eye. Op_1 not developed; Op_2 large, its diameter almost equal to maxillary width, on level of lower end of pectoral base. PLO just anterior to and slightly higher than PVO_1, directly over anterior half of PO_2. PVO_1 directly over posterior end of PO_2, anterior to and slightly below PVO_2 which is located slightly anterior to lower end of pectoral base. Five PO, the first 2 interspaces about as wide as the individual organs, the last 2 very small; PO_1 directly under Op_2; PO_5 just anterior to base of outer ventral ray; from ventral view all organs form gently and evenly diverging straight lines. VLO directly over posterior end of ventral base, about on level of lower end of pectoral base and twice as close to ventral base as to lateral line. Four VO about evenly spaced, very close together, the anterior end of each of the last 3 organs almost directly over the posterior end of the preceding ones; VO_1 immediately behind ventral base; VO_4 slightly anterior to first anal ray; from ventral view the organs form slightly curved lines, the concavity directed inward. SAO forming a scarcely curved, almost horizontal line; SAO_1 over posterior half of VO_4, separated from it by less than its own diameter; SAO_2 on same level, about over base of second anal ray, separated from SAO_1 by a space about 0.5 as great as that which separates it from SAO_3 which is located slightly higher and just above and anterior to AO_1. Fourteen AO, all in line; 2 or 3 organs behind base of last anal ray; on the left side of the type the first interspace is enlarged, on the right side the first two interspaces are narrowed so that the third organ of the right side lies opposite the second organ of the left side; a small organ on the left side is posterior to the last organ of the right side. Prc_1 very near ventral body margin at base of anterior caudal rays, separated from last AO by a space equal to about 0.6 depth of caudal peduncle; Prc_2 immediately behind Prc_1 and very slightly elevated. No luminous glands developed in the very small type.

The type is almost colorless but has a gray streak, broad in front and narrowed posteriorly, extending along the mid-dorsal line from the vertical of the anterior orbital margin to the adipose fin. A faint vertical streak of the same color extends along the caudal base, and small flecks of gray occur directly over the VLO, SAO and AO photophores.

The holotype and only known specimen (Stanford Natural History Museum No. 33656), taken by the "Zaca," Crocker-Stanford Station No. 35, is a young individual 14.7 mm. in standard length. The type locality is in the Outer Santa Barbara Passage, Lat. 33° 11' N., Long. 118° 21' 30" W., 800 fathoms of wire out.

This species differs from *Electrona normani* and *E. tenisoni*, its closest relatives, in the anterior position of the anal fin, and in the posterior position of the SAO series of photophores.

Named for Mr. Templeton Crocker, who by using his yacht the "Zaca" as a research vessel, has played an important rôle in the zoological exploration of the Pacific.

Genus *TARLETONBEANIA* Eigenmann and Eigenmann

Tarletonbeania Eigenmann and Eigenmann, 1890, p. 6 (genotype by original designation *Tarletonbeania tenua* E. and E. = *Myctophum crenulare* Jordan and Gilbert).

Caudal peduncle very slender, less than 0.08 of standard length. Narrow bands of cardiform teeth on premaxillaries; a similar but wider band on dentaries; a small patch of about 10 cardiform teeth on each side of vomer; a long band of similar teeth extending entire length of palatines; a roughly oval patch about 4 times as broad and somewhat shorter than palatine band on each entopterygoid. Gill-rakers long, those at angle equal to about 0.5 orbit. Dorsal base much shorter than anal base. Pectoral inserted low, the upper end of its base about twice as close to ventral body margin as to dorsal margin. Lateral line obsolescent, pores on the anterior 2 or 3 scales only. Dn, Vn and Suo present; 6 (5-8) PO, none elevated; 6 (5-7) VO, none elevated; 1 Pol; AO in 2 separate series; only 1 Prc. An undivided supracaudal gland developed in adult males.

This genus is monotypic. Its single species, *Tarletonbeania crenularis*, together with *Gonichthys cocco* (Cocco), *Centrobranchus nigro-ocellatus* (Günther), *C. andreae* (Lütken), and the two species which are at present known as *Myctophum rarum* (Lütken) and *M. interruptum* Tåning, constitute a comparatively diffuse line of evolution. Although only a few characters such as the more or less protruding snout and low position of the PLO serve to link all of these species together, each species possesses additional characters of considerable importance which indicate relationship to some of the other forms.

Gonichthys cocco, Centrobranchus nigro-ocellatus and *C. andreae* agree with each other in general appearance and body form, in the arrangement of photophores, the PLO being comparatively high (about opposite upper end of pectoral base) and the Pol and the AO interspace occurring far in advance of the adipose fin. In addition they agree in the development of infracaudal luminous glands in the female.

Myctophum rarum and *M. interruptum* (which seem to require a new genus for their reception) have a very different body form with a much heavier caudal peduncle, a PLO definitely below upper end of pectoral base, the Pol and the AO interspace about under adipose fin, and no infracaudal luminous gland developed in the female.

The contrasting characters indicate two distinct evolutionary lines. However, the first of these must be further divided since the excessive development of the nasal capsules, the almost complete reduction of the gill-rakers, and the loss of the lateral line in the 2 species of *Centrobranchus* appear to be so important as to demand their generic separation.

Finally, *Tarletonbeania crenularis* represents a fourth rather isolated line of development, differing from all of the other species in its crenulated scales, well developed Suo, increased number of PO, and the unique single Prc. In body form it occupies an intermediate position. The obsolescent lateral line suggests relationship to *Centrobranchus* but the general arrangement of photophores and caudal glands is similar to that of *Myctophum rarum* and *M. interruptum*. Of possible importance as an indicator of relationship to *Tarletonbeania* is the occasional development of 6 PO in *Myctophum interruptum*. This variation in a usually stable series of organs seems quite significant.

It may be well to note here that the low position of the PLO suggests re-

lationship of this complex of species to the genus *Electrona*. In all other Myctophinae the PLO occupies an elevated position definitely above the pectoral base.

Tarletonbeania crenularis (Jordan and Gilbert)

Myctophum crenulare Jordan and Gilbert, 1880, p. 274 (Santa Barbara Channel, California); Parr, 1929a, p. 5, fig. 2.
Myctophum procellarum Bean, in Jordan and Gilbert, 1881, p. 457 (type locality given as "off Vancouver Island" by Jordan and Starks, 1895, p. 793).
Tarletonbeania tenua Eigenmann and Eigenmann, 1890, p. 7 (San Diego region).
Tarletonbeania crenulare Eigenmann, 1892, p. 141.
Scopelus crenularis Lütken, 1892, p. 266.
Tarletonbeania crenularis Jordan and Starks, 1895, p. 793.
Myctophum tenua Brauer, 1904, p. 390.
Myctophum crenularis Brauer, 1904, p. 390.
Tarletonbeania crenularia Starks, 1911, p. 208 (*lapsus calami*).

In young specimens the body tapers rather evenly from vertical of pectoral base to slender caudal peduncle. In older specimens, 50 mm. or more in standard length, the body is slightly heavier with dorsal and ventral contours almost parallel between pectoral base and anus. In young individuals the upper anterior profile of head is straight or slightly concave; the snout pointed and protruding; the mouth inferior. These characters change with age, the head becoming slightly convex, the snout blunter and less protruding and the mouth almost terminal. Maxillary not at all expanded posteriorly, extending far beyond orbit, about 0.4 of its length lying behind a perpendicular to the mouth drawn through posterior margin of orbit. Eye moderate in size; orbital diameter 1.3 to 2.0 times as long as snout. Opercular margin ending in a blunt point. Gill-rakers 5

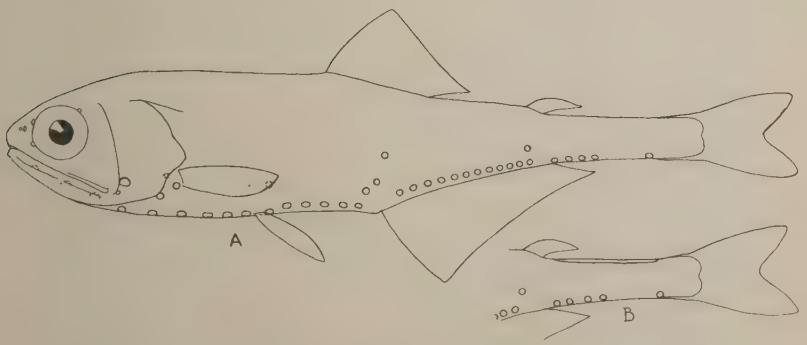

Fig. 5. *Tarletonbeania crenularis* (Jordan and Gilbert). A. Adult female. B. Caudal peduncle of adult male.

(5-6) + 1 + 11 (10-11), usually with an additional rudimentary one at anterior end of each limb (8 specimens counted).

Fin formula: D. 12 (11-14); A. 18 (17-19); P. 13 (12-14); V. 8 (7-8). Dorsal origin about midway between snout and caudal base; dorsal base 1.6 (1.4-1.9) in anal base. Anal origin about under middle of dorsal base (under sixth to ninth ray). Adipose slightly anterior to end of anal base. Pectoral base midway between snout and a point somewhere between next to last VO and anal origin; fin extending to somewhere between VO_1 and VO_3. Ventral base slightly closer to dorsal origin than to pectoral base; fin extending to somewhere between VO_4 and VO_6. General body scales crenate but this feature very variable, scarcely noticeable on some specimens; 45-50 scales in longitudinal series. In well preserved specimens a sheath of narrow elongated scales extends over the basal half of dorsal and anal fins, and enlarged scales cover the lower basal portion of pectorals and inner basal portion of ventrals.

Measurements in percent of standard length based on 50 specimens 18.1 to 79.2 mm. in standard length: length of head 28.1 (25.3-32.5); diameter of orbit 8.3 (7.0-10.1); length of maxillary 18.2 (16.0-23.9); distance from dorsal to ventral 23.4 (20.4-26.6); distance from dorsal to anal 20.3 (18.9-24.4); depth of caudal peduncle 5.8 (4.5-7.3); distance from snout to dorsal 51.0 (44.8-56.1); length of dorsal base 15.3 (13.3-16.9); distance from snout to anal 57.2 (52.3-60.8); length of anal base 24.7 (21.2-28.2); distance from snout to adipose 78.2 (71.2-81.7); distance from snout to pectoral 27.6 (24.5-31.0); distance from snout to ventral 40.0 (38.0-42.8).

A small deeply embedded Dn, a slightly larger Vn and a small Suo; one or more of these organs often difficult to distinguish. Op_1 small, opposite end of maxillary; Op_2 large, about on level of PVO_2, separated from Op_1 by a space not greater than its own diameter. PLO small, about half size of neighboring organs, slightly behind PVO_1 and below level of upper end of pectoral base. PVO_1 about midway between PO_2 and PLO, on or slightly behind a line connecting the two; PVO_2 directly over or somewhat anterior to PO_3, at base of lower pectoral rays; a line through the 2 PVO passes between PO_1 and PO_2. Six (5-8) PO; PO_1 about under Op_2; first 2 PO interspaces about twice as wide as posterior ones; from ventral view all organs form evenly diverging straight lines, first pair close together near median line, last pair just anterior to base of outer ventral rays. Since the PO and VO series of photophores are unusually variable in this species, I present in tabular form the data obtained from a count of all suitable specimens available.

		PO				
		5-6	6-6	6-7	7-7	7-8
VO	5-5		1			
	5-6		1	2		
	6-6	1	48	5	3	1
	6-7					
	7-7		2	2		

Fig. 6. Table showing variations in the number of PO and VO photophores in 66 specimens of *Tarletonbeania crenularis*. Both sides of each fish have been counted. Symmetrical arrangement of the photophores is indicated by double values (6-6) and variations between the two sides by varying numbers (6-7).

VLO about over VO_1, on a line connecting PVO_2 and SAO_2. Six (5-7) VO, first 2 or 3 organs usually slightly more widely spaced than posterior ones; VO_1 just behind and slightly mesad to base of inner ventral rays, close to midventral line; second pair markedly divergent and forming with remaining organs gently converging straight or slightly curved lines, the convexity directed outward. SAO weakly angulated; SAO_1 over and slightly behind last VO; SAO_2 somewhat higher and directly over or slightly anterior to anal origin; SAO_3 a little below middle of body and a little anterior to AO_1; SAO_2 and SAO_3 forming a straight line with anus. Eleven (9-12) + 4 (3-5) AO; AOa_1 sometimes slightly depressed or separated from AOa_2 by a somewhat enlarged interspace; AOp_1 directly over or very little behind base of last anal ray, separated from last AOa by a space equal to from 0.3 to 0.8 depth of caudal peduncle. One Pol well below middle of body, slightly behind, rarely slightly in advance of last AOa. Only 1 Prc at base of lower caudal rays, separated from last AOp by a space about twice as wide as that between last AOa and AOp_1. Males 50 mm. or more in standard length have a very well developed and conspicuous, undivided, supracaudal luminous gland extending from just behind adipose base almost to vertical of Prc. No caudal glands developed in the female.

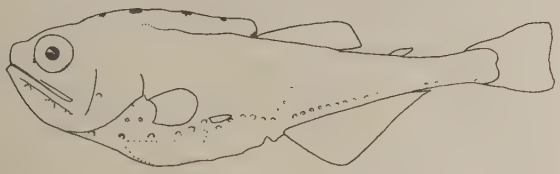

Fig. 7. *Tarletonbeania crenularis* (Jordan and Gilbert). Early metamorphosis stage, 19.4 mm. in standard length.

Color of dorsal region blue black, the dark tone extending around the base of caudal and continued forward in smudges of pale gray along the ventral photophores. A small diffuse blackish patch at base of pectorals. Body elsewhere metallic silver, with a poorly defined longitudinal line of bluish violet where the silver meets the dark tones of the back. In life the luminous organs emit a vivid electric blue light.

Included in the material studied are 7 specimens less than 22 mm. in standard length which provide a partial picture of the metamorphosis. These are all characterized by comparatively large heads and pointed, pig-like snouts. In the youngest specimen, 19.4 mm. in standard length (fig. 7), the belly is protuberant, giving the fish a very heavy bodied appearance. A ventral transparent area, permitting observation of the interior of the coelom, extends between the level of the PO_2 and the base of the ventral fin. The ventral fins as well as the developing PO and VO photophores are high on the sides of the body. A considerable portion of the median fin fold remains, extending from the head to the dorsal origin. Rays are fully developed in all of the fins, but the pectorals are

short and rounded and the ventrals very small. Most of the anterior ventral photophores are clearly defined. The Op_1, PLO, SAO, AOp, Pol and Prc organs are barely indicated. No trace of the Dn and Suo can be found. The body above the ventral photophores is smudged with gray between the verticals of preopercle and adipose fin. Five prominent melanophores are evenly spaced along the fin fold.

In a slightly older specimen 20.5 mm. in standard length the depth of the body has markedly decreased although the ventral transparent area and the dorsal fin fold remain. All photophores, with the exception of the Suo, are clearly defined. The color has darkened and a pronounced band of black encircles the body under the adipose fin.

A somewhat older specimen, 20.0 mm. in standard length (fig. 8), has assumed a form similar to the adult. The ventral bulge is gone, the dorsal fin fold is much reduced, although 3 prominent larval melanophores persist, and scales are developed. In this specimen the dark cross band under the adipose fin is represented by separate dorsal and ventral patches of black.

Another specimen 20.0 mm. in standard length is darkly colored throughout and completely scaled. It has no trace of the median fin fold, and all of the photophores, even the Suo, are as prominent as they are in adults. Metamorphosis appears to be accomplished during a period of cessation of growth or may even be accompanied by a slight decrease in size.

Fig. 8. *Tarletonbeania crenularis* (Jordan and Gilbert). Late metamorphosis stage, 20.0 mm. in standard length.

I have examined 79 specimens of *Tarletonbeania crenularis* from the following localities: from stomachs of *Germo alalunga* taken 30 to 35 miles off the mouth of the Columbia river, 4 specimens; off Cape Mendocino, California, Lat. 40° 21' N., Long. 124° 45' W., 1 specimen; off Monterey Bay, Lat. 36° 47' N., Long. 122° 04' W., 11 specimens; Lat. 36° 40' N., Long. 122° 30' W., 1 specimen; Lat. 36° 39' N., Long. 122° 02' W., 4 specimens; from stomachs of *Germo alalunga* taken 20 miles off Point Pinos, 6 specimens; from stomachs of *Germo alalunga*, Monterey fish markets, 37 specimens; off Carmel, Lat. 36° 35' N., Long. 122° 11' W., 5 specimens; from stomachs of *Germo alalunga* taken 35 miles off Point Sur, 1 specimen; San Pedro Channel, Lat. 33° 41' N., Long. 118° 46' W., 2 specimens; Lat. 33° 33' N., Long. 118° 23' W., 1 specimen; off Santa Catalina Island, 3 specimens; off southern California, Lat. 33° 05' N., Long. 122° 31' W., 1 specimen; off San Clemente Island, Lat. 32° 30' 30" N., Long. 118° 05' 10" W., 2 specimens.

This species, originally described from the Santa Barbara Channel, has

been reported from as far north as the southern part of the Gulf of Alaska, Lat. 49° N., Long. 151° W., and from as far south as the United States-Mexican border, Lat. 32° 30' 30" N., Long. 118° 05' 10" W.

Genus *MYCTOPHUM* Rafinesque

Myctophum Rafinesque, 1810, pp. 35, 56 (genotype by monotypy *Myctophum punctatum* Rafinesque).
Myctophum Cocco, 1829, p. 44 (substitute for *Myctophum; fide* Jordan 1917).
Nychtophus Cocco, 1838, p. 20 (*lapsus calami*).
Scopelus Cuvier, 1817, p. 169 (genotype by subsequent designation of Jordan 1917 *Gasteropelecus humbolti* Risso).
Dasyscopelus Günther, 1864, p. 405 (as a subgenus; genotype by subsequent designation of Goode and Bean 1895 *Myctophum asperum* Richardson).
Benthosema Goode and Bean, 1895, p. 75 (genotype by original designation *Salmo mulleri* Gmelin = *Scopelus glacialis* Reinhardt).
Hygophum Tåning, 1932, p. 133 (see page 113 below).

Teeth of jaws cardiform. Gill-rakers well developed. Dorsal base much shorter than anal base. Lateral line present, complete. No photophores above lateral line; 5 PO, the fourth never elevated; PLO definitely above pectoral base; AO in 2 separate series; Pol present; 2 (rarely 3) Prc. No luminous glands other than the definite photophores except those on caudal peduncle.

Subgenus *MYCTOPHUM* Rafinesque

Narrow bands of cardiform teeth on premaxillaries; a similar but wider band on dentaries; a small patch of similar teeth on each side of vomer, the median line naked; a long band of similar teeth on palatines and a large roughly oval patch of scattered teeth on each entopterygoid. Anal origin about under or slightly posterior to end of dorsal base; pectoral base high, its upper end about equidistant from dorsal and ventral margins. PO and VO all in line, none of the organs markedly elevated; 1 Pol; AO interspace over posterior part of anal base, at least 1 AOp over end of anal. Luminous glands of caudal peduncle distinctly divided into separate parts corresponding to the scales.

This subgenus does not form a very well-knit systematic unit and may require further subdivision. Strong variations in the general body form and the character of the scales, together with the occurrence or absence of a Dn and differences in the position of certain other photophores, indicate minor evolutionary trends but the limits of these are obscure since different sets of characters provide contradictory evidence.

Due partially to this fact and partially to the omission of much pertinent information from most current descriptions, it is impossible to estimate in a satisfactory manner the interrelationships of the forms in question. Of the three species discussed in this report, *Myctophum aurolaternatum* appears to occupy a somewhat intermediate position, agreeing with *M. affine* in having the SAO in a straight line and the AO interspace near the end of the anal base, but showing what is probably a closer relationship to *M. californiense* by its slender body form and lack of a Dn.

Myctophum (Myctophum) californiense Eigenmann and Eigenmann

Myctophum californiense Eigenmann and Eigenmann, 1889, p. 124 (Cortez Banks, off San Diego); Parr, 1929a, p. 10, fig. 4.
Scopelus californiensis Lütken, 1892, p. 267.
Myctophum (Myctophum) humboldti Brauer, 1906, p. 192 (partim).

Body moderately robust, tapering rather evenly from nape to caudal peduncle. Upper anterior profile of head flat or slightly concave above eyes; snout steep and rounded; mouth terminal. Maxillary slightly expanded posteriorly, its hind margin forming an oblique curve, the upper angle well in advance of lower; extending well beyond eye, about 0.3 of its length lying behind a perpendicular to mouth drawn through posterior margin of orbit. Eye moderate in size, orbital diameter 1.5 to 2.0 times as long as snout. Opercular margin ending in a very short but rather sharp point. Gill-rakers long, slender, those at angle slightly longer than 0.5 diameter of orbit; 6 (6-7) + 1 + 15 (14-16) on first arch (5 specimens counted).

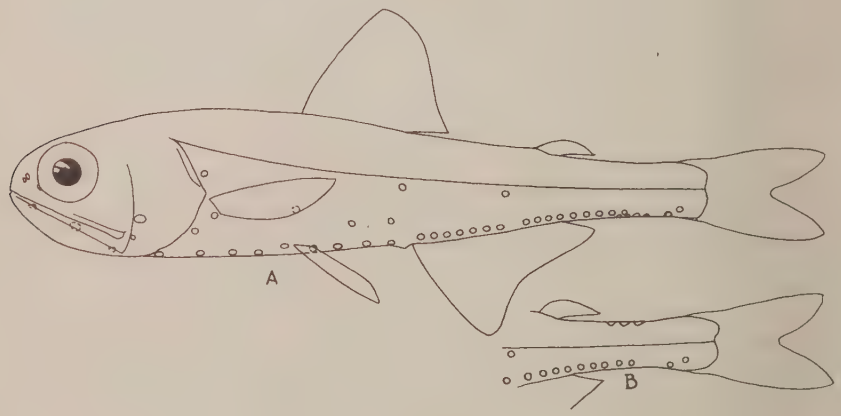

Fig. 9. *Myctophum californiense* Eigenmann and Eigenmann. A. Adult female. B. Caudal peduncle of adult male.

Fin formula: D. 14 (14-15); A. 20 (20-21); P. 17 (16-18); V. 8. Dorsal origin midway between snout and a point somewhere between AOp_2 and AOp_3; dorsal base 1.6 (1.4-1.8) in anal base. Anal origin directly under or slightly posterior to end of dorsal base. Adipose slightly anterior to end of anal base. Pectoral base midway between snout and a point somewhere between VO_4 and AO_1; fin extending to VO_2 or VO_3; ventral base very slightly anterior to dorsal origin, fin ex-

tending about to anus. Scales cycloid, 41-42 in lateral line.

Measurements in percent of standard length, based on 8 specimens 24.0 to 103.3 mm. in standard length: length of head 28.8 (25.0-32.5); diameter of orbit 8.3 (7.5-9.3); length of maxillary 19.0 (16.2-20.8); distance from dorsal to ventral 17.6 (14.7-19.9); distance from dorsal to anal 23.3 (21.3-25.8); depth of caudal peduncle 7.1 (5.9-8.4); distance from snout to dorsal 45.1 (43.3-48.3); length of dorsal base 14.6 (13.7-15.7); distance from snout to anal 60.1 (57.8-63.7); length of anal base 23.2 (21.9-24.3); distance from snout to adipose 77.1 (74.0-80.5); distance from snout to pectoral 29.8 (27.7-32.5); distance from snout to ventral 42.8 (41.0-45.4).

A small deeply embedded Vn, often difficult to distinguish. Op_1 small, opposite lower, posterior angle of maxillary; Op_2 larger than neighboring organs, slightly above level of PVO_1, separated from Op_1 by a space equal to or somewhat greater than its own diameter. PLO slightly behind PVO_1, about midway between lateral line and upper end of pectoral base. PVO_1 directly over or somewhat in advance of PO_2, about on a line connecting PO_1 and PVO_2 which is at base of lower pectoral rays and well in advance of PO_3. Five PO; PO_1 well behind Op_2, these organs not touching same vertical; third interspace markedly narrower than preceding ones, slightly narrower than last interspace; from ventral view the anterior 4 organs form gently diverging straight or slightly curved lines, the convexity directed outward; PO_5 abruptly divergent, just antero-mesad to base of outer ventral rays. VLO directly over base of outer ventral ray, about midway between ventral base and lateral line. Four VO, about evenly spaced; VO_1 just postero-mesad to base of inner ventral rays; from ventral view all organs form parallel lines or the last 3 pairs are very slightly displaced laterally. SAO strongly angulated; SAO_1 somewhat behind VO_2, well below level of VLO; SAO_2 directly over or slightly in advance of VO_4, on same level as SAO_1; SAO_3 about over anus, its own diameter or slightly less below lateral line. Seven (6-7) + 9 (8-10) AO; all in line and about equally spaced; first 3 or 4 AOp over anal base; AOp_1 separated from last AOa by an interspace equal to about 0.3 depth of caudal peduncle. One Pol slightly behind last AOa, its own diameter or slightly less below lateral line. Prc_1 near ventral body margin, separated from last AOp by an interspace about 1.5 times as wide as that between the last AOa and first AOp; Prc_2 somewhat elevated but nearer base of lower caudal rays than lateral line. In my material, a male specimen 52.4 mm. in standard length has 3 small, well isolated, supracaudal luminous glands extending from slightly in front of the next to the last AOp to slightly behind the last organ in this series. A female 81.3 mm. in standard length has 4 similar infracaudal glands extending from the next to last AOp to the middle of the AO-Prc interspace. According to Gilbert (1913), adult males 127 mm. in length have the entire back of caudal peduncle covered by a series of 6 large plates preceded by 1 or 2 small ones, while females of the same size from Japan have 7 or 8 distinct plates covering the area between the anal fin and the caudal.

Sides of body metallic silvery, dorsal region black, all fins smudged with blackish near base. In life the luminous organs emit a pale greenish light.

I have examined 8 specimens of this species from the following localities: off central California, Lat. 37° 30' N., Long. 127° 23' W., 1 specimen; Lat. 35° 02' N., Long. 126° 47' W., 1 specimen; 200 miles off Point Conception, 1 specimen; off Santa Cruz Island. Lat. 33° 40' N., Long. 119° 32' W., 1 specimen; San Pedro Channel, Lat. 33° 41' N., Long. 118° 46' W., 1 specimen; Outer Santa Barbara Passage, Lat. 33° 12' N., Long. 118° 23' W., 2 specimens; Misaki, Japan,

1 specimen.

This species is known from both shores of the Pacific, ranging between southern British Columbia and the United States-Mexican border on the east, and from western Hokkaido to Sagami Bay on the west.

Myctophum (Myctophum) aurolaternatum Garman

Myctophum aurolaternatum Garman, 1899, p. 264, pl. 55, fig. 3 (Albatross station 3382, off the Pacific coast of Panama).

Body slender, tapering rather evenly from nape to moderately slender caudal peduncle. Upper anterior profile of head gently rounded; snout steep, bluntly rounded; mouth terminal. Maxillary very slightly and evenly expanded posteriorly, its posterior margin evenly rounded; extending well beyond orbit, about 0.3 of its length lying behind a perpendicular to mouth drawn through posterior margin of orbit. Eye moderate in size, orbital diameter about 1.5 times length of snout. Opercular margin ending in a short, blunt point. Gill-rakers long, slender, those at angle equal to about 0.6 diameter of orbit; 4 (4-5) + 1 + 11 (11-12) on first arch (6 specimens counted).

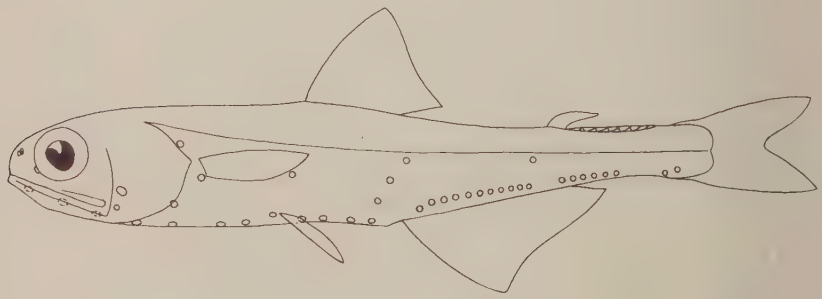

Fig. 10. *Myctophum aurolaternatum* Garman.

Fin formula: D. 14 (13-14); A. 24 (23-24); P. 12 (12-13); V. 8. Dorsal origin midway between snout and a point somewhere between third and last AOp; dorsal base 1.8 (1.7-2.0) in anal base. Anal origin directly under or slightly posterior to end of dorsal base. Adipose slightly in advance of end of anal base. Pectoral base about midway between snout and anal origin; fin extending to VO_1 or VO_2. Ventral base 2 or 3 times as far from pectoral base as from dorsal origin; fin extending almost or quite to VO_4. Scales cycloid, 45-48 in lateral line.

Measurements in percent of standard length based on 6 specimens 31.0 to 72.4 mm. in standard length: length of head 28.2 (27.1-29.1); diameter of orbit

8.3 (7.9-8.7); length of maxillary 16.7 (16.0-17.4); distance from dorsal to ventral 17.0 (16.1-18.1); distance from dorsal to anal 22.0 (21.0-23.7); depth of caudal peduncle 6.8 (6.5-7.4); distance from snout to dorsal 45.7 (44.7-47.5); length of dorsal base 14.1 (13.7-14.9); distance from snout to anal 57.3 (55.8-59.5); length of anal base 25.7 (23.3-27.8); distance from snout to adipose 81.2 (80.0-82.6); distance from snout to pectoral 29.9 (28.8-32.2); distance from snout to ventral 41.1 (40.2-41.9).

A small Vn. Op_1 almost as large as general body photophores but deeply embedded, often indistinct, opposite lower posterior angle of maxillary; Op_2 a little larger than neighboring organs, slightly above level of PVO_1, separated from Op_1 by a distance about equal to its own diameter. PLO slightly behind PVO_1, midway between lateral line and upper end of pectoral base or slightly lower. PVO_1 directly over or slightly in advance of PO_2, about on a line connecting PO_1 and PVO_2 which is at base of lower pectoral rays, well in advance of PO_3. Five PO; PO_1 well behind Op_2, these organs not touching same vertical; first 2 interspaces subequal or the second slightly the larger, almost twice as great as third which is equal to or slightly smaller than fourth; from ventral view the middle 3 organs form parallel lines, the first organs displaced slightly toward the midline, the last abruptly divergent, located just in advance of and very slightly mesad to base of outer ventral rays. VLO about over middle of ventral base, midway between ventral base and lateral line or slightly higher. Four VO, about evenly spaced; VO_1 just postero-mesad to inner ventral rays, last 3 organs very slightly displaced laterally, forming parallel straight lines. SAO about equally spaced on an oblique straight line which passes through or slightly anterior to VO_4; SAO_1 slightly behind VO_4 (absent on one side of one specimen); SAO_2 about over anus; SAO_3 slightly in advance of AO_1, less than its own diameter below lateral line. Eleven (10-11) + 5 (4-6) AO about evenly spaced; first 1 or 2 AOa noticeably depressed; AOp_1 about over base of last anal ray, separated from last AOa by a space equal to from 0.5 to 0.7 depth of caudal peduncle. A single Pol directly over or somewhat behind last AOa, almost in contact with lateral line. Prc_1 near ventral body margin, separated from last AOp by a space 1.2 to 1.8 times as wide as that between last AOa and first AOp; Prc_2 slightly elevated but much nearer base of lower caudal rays than lateral line. On one side of one specimen there are 3 Prc in a gently ascending straight line. My two largest specimens, 64.0 and 72.4 mm. in standard length, have a line of 7 or 8 supracaudal luminous glands, each one outlined in black, extending from adipose fin to or almost to Prc_1. In the largest individual similar small glands occur lateral to the anterior ones of the main series. None of the other specimens have any indication of either supra- or infracaudal luminous scales although one of them is quite large, measuring 60.8 mm. in standard length.

General body color metallic bluish silvery with dorsal areas a dark bluish black. Entire body blackish when scales are lost.

I have examined 6 specimens of *Myctophum aurolaternatum* from the following localities: mouth of the Gulf of California, 4 specimens; off Panama, Lat. 5° 00' N., Long. 83° 30' W., 1 specimen; Lat. 3° 40' N., Long. 85° 15' W., 1 specimen.

This species is apparently confined to the warm waters of the eastern Pacific. The specimens recorded above seem to be the first ones taken since the capture of the types at Lat. 6° 21' N., Long. 80° 41' W. They are in the collections of the California Academy of Sciences.

Myctophum (Myctophum) affine (Lütken)

Scopelus affinis Lütken, 1892, p. 252, fig. 10 (Atlantic and Indian Oceans at numerous localities between Lat..38° 40' N., Long. 63° 00' W. and Lat. 39° 53' S., Long. 41° 30' E.).
Myctophum affine Goode and Bean, 1895, p. 72.
Myctophum (Myctophum) affine Brauer, 1906, p. 190 (partim).

This species presents a most exasperating problem. Either we are concerned with a very variable, almost cosmopolitan species or with a group of very closely related species which have not as yet been characterized in the literature, or at best inadequately.

Included in the material at my disposal are three very distinct and separate types, all of which key down to *Myctophum affine* and which are in perfect accord in regard to photophores. One of these, represented by specimens from the Carolina coast and from the northeastern Pacific appears to be the true *M. affine* of Lütken. Another, an apparently undescribed species from the southeastern Polynesian region, is easily distinguished by the extremely blunt snout and large eye and particularly by the increased number of pectoral rays (about 20 instead of 15 or less). The third species, represented by two specimens 49.4 and 62.6 mm. in standard length, from the coast of Peru, shows striking differences when compared directly with *M. affine* of similar size. In these specimens the snout descends gradually to a bluntly rounded point instead of being abruptly declivous, the mouth is slightly inferior instead of strictly terminal, the eye is definitely smaller (8.5-9.1 instead of 10.1-11.5), and the body is less heavy anteriorly. It is possible that these specimens belong to *M. nitidulum* Garman, for although Garman's standards of description were not sufficiently exact to permit a conclusion to be reached from the text, his figure looks very much like the Peruvian material.

Evidence of further specific differentiation in Atlantic material is suggested by a perusal of the data presented by Parr (1928). The two readily recognizable light and dark forms found in the Bahama region, which are definitely differentiated by non-intergrading variations in the number of luminous organs, appear to me to be distinct species. The light form seems to be *Myctophum affine*. The occurrence of specimens in other parts of the world with the intermediate number of 13 AO photophores seems to be evidence of a wider range of variation in regard to this particular character in one or possibly both of these species than is encountered in the restricted Bahama area. It is no guarantee of intergradation in the other differentiating characters. No convincing evidence is presented of specimens intermediate in color, and no evidence at all to prove the complete intergradation of the adult males having four supracaudal luminous scales with those having seven.

Further, I consider the status of *Myctophum opalinum* Goode and Bean, as a synonym of *M. affine*, to be dubious. I have examined 4 specimens, 20.0 to 44.5 mm. in standard length, from "Albatross" stations 2587 and 2727, which formed part of Goode and Bean's material of *M. opalinum* as reported in their Oceanic Ichthyology. All of the specimens, with the exception of the smallest one, from which all of the scales are missing, display various degrees of crenulations or teeth on the scale margins. In the largest specimens the scales are moderately ctenoid, differing markedly from those of typical *M. affine* of similar size or

larger. Either these specimens represent a perfectly good species, or they are a variety of either the cycloid-scaled *M. affine* or of the very strongly ctenoid-scaled *M. spinosum* Steindachner, or possibly they provide the intergrades which may require the reduction of *M. affine* to the status of a synonym of *M. spinosum*. It is interesting to note in this connection that the type of *Rhinoscopelus oceanicus* Jordan and Evermann, which is usually considered to be a synonym of *M. affine*, is reported by its authors (1903) to have "scales large, undulated and very irregularly and sparingly toothed or crenate" although the figure of this specimen presented by Jordan and Evermann (1905) shows no indication of this feature.

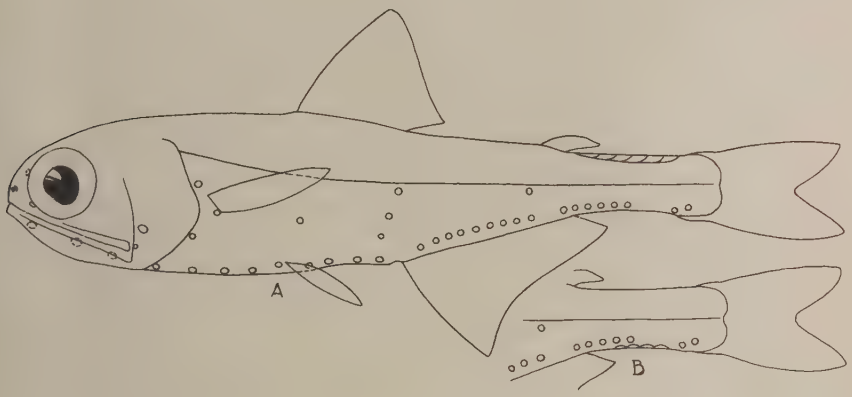

Fig. 11. *Myctophum affine* (Lütken). A. Adult male. B. Caudal peduncle of adult female.

Under these circumstances, I am unable to agree with the statement of Parr (1928) that, "the identity of the five variously named descriptions of this species (*affine, opalinum, nitidulum, oceanicus* and *margaritatum*) has already been established beyond any doubt by Brauer 1906 and by Gilbert 1908 and 1913." It is highly desirable that very careful statistical studies of characters other than photophores be carried out on very extensive material of *Myctophum affine* and its close relatives gathered from all parts of the world. It is probable that only in this manner can the specific limits definitely be determined, the distribution be charted with some degree of accuracy, and synonomies be produced which have some meaning.

Body robust, tapering evenly from nape to moderately heavy caudal peduncle. Upper anterior profile gently rounded; snout steep, blunt; mouth terminal. Maxillary very slightly expanded posteriorly; its posterior margin forming an oblique curve, the upper angle well in advance of lower; extending well beyond orbit, about 0.3 of its length lying behind a perpendicular to mouth drawn through posterior margin of orbit. Eye large, orbital diameter about twice length of

snout. Opercular margin ending in a broadly rounded lobe. Gill-rakers long, slender, those at angle equal to about 0.5 diameter of orbit; 5 (5-6) + 1 + 14 (13-15) on first arch (7 specimens counted).

Fin formula: D. 14 (13-14); A. 20 (19-21); P. 14 (13-15); V. 8. Dorsal origin midway between snout and a point somewhere between AOp_2 and AOp_5; dorsal base 1.7 (1.6-1.9) in anal base. Anal origin about under end of dorsal base. Adipose slightly in advance of end of anal base. Pectoral base about midway between snout and anus; fin extending to VO_2 or VO_3. Ventral base very slightly anterior to dorsal origin; fin extending almost or quite to anus. Scales cycloid, 38-39 in lateral line.

Measurements in percent of standard length based on 9 specimens 28.7-72.0 mm. in standard length: length of head 29.0 (27.5-30.0); diameter of orbit 10.7 (10.1-11.5); length of maxillary 19.1 (18.1-20.2); distance from dorsal to ventral 23.0 (21.0-26.0); distance from dorsal to anal 26.5 (25.0-28.5); depth of caudal peduncle 7.7 (5.1-9.0); distance from snout to dorsal 45.4 (43.0-47.1); length of dorsal base 14.8 (13.9-15.6); distance from snout to anal 58.9 (56.8-61.0); length of anal base 25.6 (23.5-26.6); distance from snout to adipose 78.3 (75.6-79.2); distance from snout to pectoral 30.0 (28.7-31.4); distance from snout to ventral 41.8 (40.1-42.9).

Body photophores usually with a poorly developed dark septum similar to that found in the genus *Diaphus*. The strand of pigment is seldom complete, but assumes the form of a broken line of from 1 to 3 dark spots. A small Dn, deeply embedded and usually not evident without dissection; a similar but clearly visible Vn. Op_1 slightly smaller than neighboring organs, opposite lower posterior angle of maxillary; Op_2 a little larger than general body photophores, very slightly above level of PVO_1, separated from Op_1 by a distance about equal to its own diameter. PLO directly over or slightly behind PVO_1, markedly nearer pectoral base than lateral line. PVO_1 directly over or slightly behind PO_2, on a line connecting PO_1 and PVO_2 which is at base of lower pectoral rays and directly over or slightly in advance of PO_3. Five PO; PO_1 behind Op_2, the two organs usually not touching the same vertical; first interspace equal to or slightly greater than second, markedly greater than third which is equal to or slightly smaller than fourth; from ventral view the anterior 4 organs form very gently diverging lines, fifth pair more widely divergent, located just in advance of and slightly mesad to base of outer ventral rays. VLO slightly anterior to VO_1, about midway between lateral line and ventral base. Four VO, about evenly spaced or with first interspace slightly enlarged; VO_1 just postero-mesad to inner ventral rays; all organs forming parallel straight lines. SAO on an oblique straight line which passes between VO_3 and VO_4, or through VO_4 in some Atlantic specimens; SAO_1 over or a little behind VO_4, about on level of PVO_1; SAO_2 about over anus, slightly closer to SAO_1 than to SAO_3; SAO_3 directly over or slightly behind anal origin, less than its own diameter from lateral line. Nine (8-9) + 6 (4-7) AO; the first 1 to 3 organs often slightly depressed, first interspace usually slightly enlarged; first 1 or 2 AOp over end of anal base, AOp_1 separated from last AOa by a space equal to from 0.3 to 0.5 depth of caudal peduncle. A single Pol about over last AOa, less than its own diameter below lateral line. Prc_1 near ventral body margin, separated from last AOp by a space 1.0 to 1.8 times as wide as that between last AOa and first AOp; Prc_2 slightly elevated, but much nearer base of lower caudal rays than lateral line. Adult males with 6 distinct and dark bordered supracaudal luminous glands extending from vertical of first, second or third AOp to vertical of Prc_1 or Prc_2. Adult females with 3 or 4 infracaudal luminous glands extending

from next to last AOp almost to Prc_1. These luminous glands are developed in all specimens over 39 mm. in standard length but no trace of them occurs in a young specimen 28.7 mm. long.

General body color metallic bluish silver, with a dark dorsal area extending from head to caudal.

In attempting to base my description upon what seemed to me to be undoubted material of *Myctophum affine*, I have utilized only 9 specimens from the following localities: open Pacific, Lat. 35° 02' 10" N., Long. 138° 37' 50" W., 4 specimens; off Guadalupe Island, 2 specimens; Atlantic Ocean, off Cape Fear, Lat. 32° N., Long 76° W., 3 specimens. Thirty-seven specimens which may well belong to this species, including 26 cotypes of *M. margaritatum* from Hawaii, 3 specimens from Panama and 3 from the open Pacific have been excluded from consideration because of their small size or poor state of preservation.

Subgenus *HYGOPHUM* Tåning

Hygophum Tåning, 1932, p. 133 (as a subgenus; genotype hereby designated as *Scopelus hygomi* Lütken).

It should be pointed out that the subgeneric name *Hygophum* has had no valid nomenclatural status until the present time due to Tåning's failure to publish either a summary of characters or any definite bibliographic reference to such a summary, and also to his failure to designate a type species. It can not be too strongly stressed that strict adherence to the rules is the best method of achieving nomenclatural stability and that workers introducing new generic or subgeneric names should always include a diagnosis and an unambiguous designation of the type species as is now required by the amendment to Art. 25 of the International Rules of Zoological Nomenclature.

Teeth in narrow cardiform bands on premaxillaries and dentaries; vomer bearing on each side a strongly protruding lobe devoid of teeth, but with a few minute teeth on its median area just posterior to the lobes; very narrow long bands of cardiform teeth on palatines and a large oval area of scattered, minute teeth on entopterygoids. Pectoral base high, its upper end about equidistant from dorsal and ventral margins. Four VO, the second not elevated; 2 Pol; AO interspace in advance of end of anal base, at least 2 AOp over end of anal; Prc_2 markedly elevated, usually close to or in contact with lateral line. Supra- and infracaudal luminous glands distinctly subdivided.

The fishes of this subgenus, immediately distinguished from their close relatives by having 2 Pol, form a beautifully circumscribed group. The individual species are differentiated from each other mainly by slight variations in body proportions and position of a few photophores. *Myctophum reinhardtii* seems to be most closely related to *M. hanseni* Tåning and *M. macrochir* (Günther). *Myctophum benoiti* (Cocco) with its comparatively low Prc_2 is probably nearest to the ancestral stock, while *M. hygomi* (Lütken) with an unusually high VLO seems to be the most specialized member of the group.

Myctophum (Hygophum) reinhardtii (Lütken)

Scopelus reinhardtii Lütken, 1892, p. 257 (partim), fig. 16 (off Madeira).

Myctophum reinhardtii Goode and Bean, 1895, p. 74.
Myctophum atratum Garman, 1899, p. 268 (Albatross station 3433 in the Gulf of California).
Myctophum benoiti reinhardti Brauer, 1904, p. 388.
Myctophum braueri Gilbert, 1905, p. 598 (Albatross station 3980, south of Oahu, Hawaiian Islands).
Myctophum lutkeni Gilbert, 1905, pl. 70, fig. 1 *(lapsus calami pro Myctophum braueri)*.

Body robust throughout, tapering from nape to heavy caudal peduncle, with a more abrupt descent under dorsal and adipose fins. Upper anterior profile evenly rounded or slightly flattened above eyes; snout steep, bluntly rounded; mouth terminal. Maxillary markedly and abruptly widened posteriorly, a ventral expansion extending mesad to and well below posterior part of premaxillary; short,

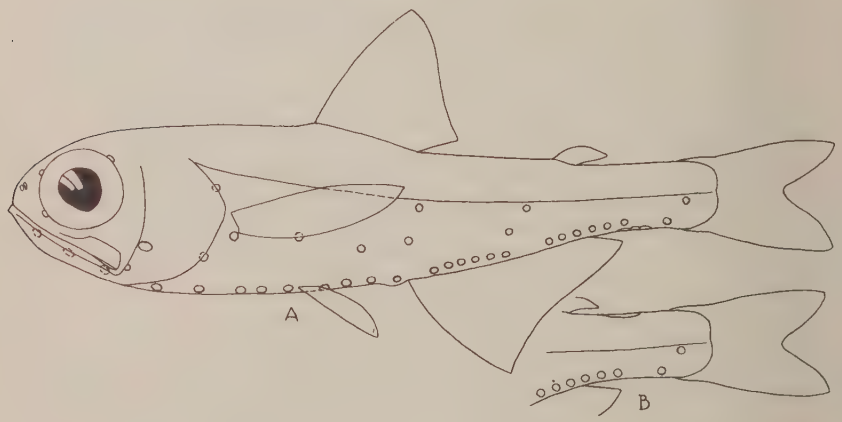

Fig. 12. *Myctophum reinhardtii* (Lütken). A. Adult female. B. Caudal peduncle of adult male.

only about 0.2 of its length lying behind a perpendicular to mouth drawn through posterior margin of orbit. Eye large, orbital diameter a little more than twice length of snout. Opercular margin rather evenly rounded. Gill-rakers long, slender, those at angle equal to about 0.5 diameter of orbit; 4 + 1 + 13 (12-13) on first arch (6 specimens counted).

Fin formula: D. 13 (12-14); A. 20 (19-23); P. 14 (12-14); V. 8. Dorsal origin midway between snout and last or next to last AOp; dorsal base 1.9 (1.7-2.2) in anal base. Anal origin under or slightly in advance of end of dorsal base. Adipose fin slightly in advance of end of anal base. Pectoral base midway between snout and AO_2; fin extending to somewhere between anus and AO_2. Ventral base slightly anterior to dorsal origin; fin extending about to anus. Scales

cycloid, or weakly crenate on upper anterior part of body; 38-40 in lateral line.

Measurements in percent of standard length based on 26 specimens 17.7 to 31.2 mm. in standard length: length of head 31.4 (26.3-33.8); diameter of orbit 12.8 (11.9-14.2); length of maxillary 19.7 (17.0-21.3); distance from dorsal to ventral 22.6 (17.7-25.4); distance from dorsal to anal 26.0 (21.2-29.0); depth of caudal peduncle 9.1 (7.5-10.2); distance from snout to dorsal 45.5 (43.0-47.8); length of dorsal base 14.2 (12.6-15.5); distance from snout to anal 58.9 (55.3-61.0); length of anal base 26.9 (24.7-29.8); distance from snout to adipose 79.2 (76.9-81.3); distance from snout to pectoral 32.5 (30.1-34.0); distance from snout to ventral 43.8 (40.4-46.5).

A small Dn, often difficult to distinguish; a somewhat larger Vn and a similar Suo. Op_1 small but well developed, very distinct, opposite middle or lower part of maxillary expansion; Op_2 markedly larger than neighboring organs, slightly above level of PVO_1, separated from Op_1 by a distance somewhat greater than its own diameter, PLO well behind PVO_1, about midway between lateral line and pectoral base. PVO_1 over and slightly behind, rarely slightly in front of PO_2, on or a little above a line connecting PO_1 and PVO_2 which is at base of lower pectoral rays and usually slightly anterior to, rarely slightly behind, PO_3. Five PO; PO_1 behind Op_2, the two organs usually not touching the same vertical; first 2 interspaces much larger than third which is about equal to diameter of a single organ and equal to or usually somewhat smaller than fourth interspace; from ventral view the anterior 4 organs form gently diverging straight lines; fifth pair more widely divergent, located just in advance of and slightly mesad to base of outer ventral rays. VLO directly over base of outer ventral ray, about midway between lateral line and ventral base. Four VO (5 on one side of 1 specimen) about evenly spaced or with anterior interspace slightly enlarged and posterior one slightly reduced; VO_1 just postero-mesad to base of inner ventral rays, remaining organs forming gently diverging or parallel straight lines. SAO sharply angulated; SAO_1 over second VO interspace, markedly nearer ventral body margin than lateral line, a little below a line connecting VLO and SAO_2 which is about over or somewhat in advance of anal origin and about on a line connecting SAO_1 and Pol_1; SAO_3 slightly anterior to AO_1, immediately below or in contact with lateral line. Six (4-7) + 6 (6-8) AO; AO_1 and often AO_2 slightly depressed, all organs about evenly spaced; first 3 or 4 AOp over posterior end of anal base; AOp_1 separated from last AOa by a space about equal to 0.5 depth of caudal peduncle. Two Pol; Pol_1 directly over or slightly behind last AOa, about midway between next to last AOa and Pol_2 which is well anterior to AOp_1 and in contact with lateral line. Prc_1 near ventral body margin, separated from last AOp by a space about as wide as that between last AOa and AOp_1; Prc_2 markedly elevated, immediately below lateral line or in contact with it, well behind Prc_1. Specimens over 25 mm. in standard length have luminous glands developed. Males have a supracaudal luminous gland which shows slight indication of division into 3 parts, extending from vertical of next to last AOp to about middle of the AOp-Prc interspace. In females 2 or 3 distinctly separate infracaudal luminous glands extend from last AOp interspace almost to Prc_1.

General body color in alcohol pale brown with silvery reflections on lateral and ventral surfaces where scales remain.

I have examined 31 specimens of this species 17.7 to 31.2 mm. in standard length from the following localities: Hawaiian Islands, Lat. 22° 10' 00" N., Long. 155° 35' 45" W., 1 specimen; Lat. 21° 23' N., Long. 158° 19' W., 7 specimens (paratypes of *Myctophum braueri* Gilbert); Philippine Islands, Lat. 13° 10' 35"

N., Long. 122° 27' 30" E., 1 specimen; Lat. 10° 47' 00" N., Long. 124° 06' 30" E., 22 specimens.

This species appears to be very widely distributed, having been reported from many stations in the Atlantic, Pacific and Indian Oceans between Latitudes 34° 22' N. and 31° 00' S. The only record for the region under discussion seems to be that of Garman (1899) who lists the type of *Myctophum atratum* from the Gulf of California, Lat. 25° 26' 15" N., Long. 109° 48' W.

Subgenus *BENTHOSEMA* Goode and Bean

Narrow bands of cardiform teeth on premaxillaries; a similar but wider band on dentaries; a small patch of similar teeth on each side of vomer, the median line naked; a long band of similar teeth on palatines and a large roughly oval patch on each entopterygoid. Four VO, the second elevated; 1 Pol; AO interspace over posterior part of anal base, at least 1 AOp over end of anal; Prc_2 strongly elevated, nearer lateral line than ventral margin of caudal peduncle.

Within the subgenus *Benthosema* we are confronted with other minor groups of species. *Myctophum glaciale* (Reinhardt) and *M. parvimanum* (Günther) are evidently very closely related, agreeing in the moderately attenuated body form, in the SAO forming a slightly curved line approaching the horizontal, in a Pol distinctly in advance of the adipose fin, and in a comparatively low Prc_2. Another closely related pair of species is *M. suborbitale* Gilbert and *M. simile* Tåning. These fishes are deeper bodied, have a strongly angulated SAO, a Pol about under anterior end of adipose fin, a very high Prc_2 and have developed an So photophore rather far posterior in position. Possessing some characters in common with each of these two groups, but divergent in regard to the high position of its PLO, is *M. fibulatum* Gilbert and Cramer. *Myctophum pterotum* appears to be the most isolated member of the subgenus, strongly differentiated from all of the other species by the peculiarly contracted pupil, tongue-shaped terminal process of opercle, and extremely high Op_2.

Myctophum (Benthosema) pterotum (Alcock)

Scopelus (Myctophum) pterotus Alcock, 1890a, p. 217 (Investigator station 96, off the Madras Coast).
Myctophum pterotus Goode and Bean, 1895, p. 511.
Myctophum pterotum Garman, 1899, p. 401.
Myctophum gilberti Evermann and Seale, 1907, p. 55, fig. 1 (Bulan Sorsogon, Luzon, Philippine Islands).
Myctophum pterotum panamense Tåning, 1932, p. 129, fig. 3 (Gulf of Panama).

Unfortunately, lack of local material has forced me to base the following description entirely upon material from the western Pacific. Since no specimens from American waters were available, I have deemed it inadvisable to enter any discussion of the subspecies established by Tåning (1932), but material from this area should be carefully compared with his description of *Myctophum pterotum panamense*.

Body robust throughout; upper profile evenly rounded or rarely slightly

flattened above eyes; snout bluntly pointed; mouth terminal. Maxillary markedly widened posteriorly due mainly to a ventral expansion which extends mesad to and slightly below posterior part of the premaxillary; rather long, about 0.3 of its length lying behind a perpendicular to mouth drawn through posterior margin of orbit. Eye large, orbital diameter about twice length of snout; pupil strictly circular, peculiarly contracted, its diameter 3 to 4 in orbit. Opercular margin abruptly produced into a sharply pointed, membranous flap. Gill-rakers long, those at angle about equal to 0.7 diameter of orbit; 7 (7-8) + 1 + 16 (15-16) on first arch (6 specimens counted).

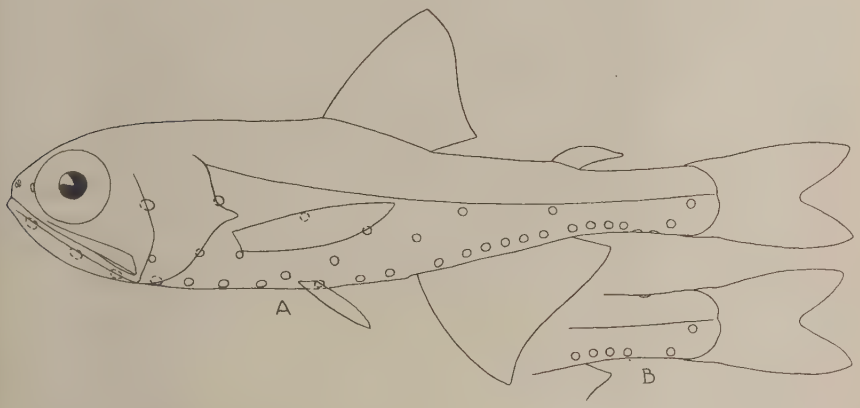

Fig. 13. *Myctophum pterotum* (Alcock). A. Adult female. B. Caudal peduncle of adult male.

Fin formula: D. 13 (12-14); A. 18 (17-19); P. 12 (11-13); V. 8 (8-9). For specimens from Panama Bay, Tåning (1932) gives the divergent fin-counts: A. 20-22; P. 14. Dorsal origin midway between snout and a point somewhere between last AOp and Prc_1; dorsal base 1.4 (1.3-1.7) in anal base. Anal origin under posterior part of dorsal base (tenth to twelfth ray). Adipose fin about over end of anal base. Pectoral base midway between snout and a point somewhere between anal origin and AOa_2; fin extending about to vertical of anus. Ventral base 3 or 4 times as far from pectoral base as from dorsal origin; fin extending almost or quite to anus. Scales cycloid; about 30-33 in lateral line.

Measurements in percent of standard length based on 28 specimens 30.8 to 88.1 mm. in standard length: length of head 34.1 (31.5-39.3); diameter of orbit 10.5 (8.9-12.7); length of maxillary 21.0 (19.2-23.5); distance from dorsal to ventral 23.3 (21.5-25.8); distance from dorsal to anal 25.7 (23.9-27.8); depth of caudal peduncle 9.9 (8.5-11.2); distance from snout to dorsal 47.9 (45.8-51.6); length of dorsal base 16.9 (14.3-18.4); distance from snout to anal 61.4 (57.7-63.8); length of anal base 24.3 (21.0-26.2); distance from snout to adipose 80.6

(76.2-85.1); distance from snout to pectoral 33.6 (31.6-36.7); distance from snout to ventral 43.6 (41.0-46.2).

A small Vn on or very slightly below level of nostrils. Op_1 well developed, prominent, opposite upper part of maxillary expansion; Op_2 little larger than neighboring organs, partly under preopercle, very high, almost on level of PLO, slightly anterior to Op_1 and separated from it by a space equal to 3 or 4 times its own diameter. PLO well behind PVO_1, about midway between lateral line and pectoral base. PVO_1 slightly posterior to PO_2, forming one straight line with PO_2 and PLO and another with Op_1 and PVO_2; PVO_2 at base of lower pectoral rays, somewhat behind PO_3. Five PO; PO_1 on a line passing through the 2 Op photophores; first three interspaces about equal to each other and greater than last; from ventral view anterior 4 organs form straight or gently curved lines with the convexity directed outward; PO_5 widely divergent, located a little anterior and dorsal to base of outer ventral rays. VLO directly over or very slightly behind base of outer ventral rays, about twice as close to lateral line as to ventral base. Four VO; VO_1 directly behind base of inner ventral rays; VO_2 elevated markedly above level of PO_5; interspace between VO_1 and VO_3 somewhat greater than that between VO_3 and VO_4; from ventral view VO_1, VO_3 and VO_4 form parallel or slightly diverging straight lines. SAO angulated; SAO_1 slightly behind VO_3, nearer lateral line than ventral margin; SAO_2 somewhat lower, directly over or very little behind anal origin; these two organs forming a straight line with VLO and PLO; SAO_3 over or slightly behind AO_2, about its own diameter below lateral line. Six (5-6) + 4 (4-5) AO; AO_1 slightly depressed, followed by an enlarged interspace about equal to that separating last AOa and AOp_1, second interspace often enlarged to a lesser degree; AOp_1 about over end of anal base, separated from last AOa by an interspace equal to about 0.3 depth of caudal peduncle. Pol somewhat behind last AOa, less than its own diameter below lateral line. Prc_1 near ventral body margin, separated from last AOp by an interspace 1.5 to 2.0 times as wide as that between last AOa and AOp_1; Prc_2 markedly elevated, immediately below or in contact with lateral line, well behind Prc_1. One or two small, poorly developed, widely separated, infracaudal, luminous patches at vertical of AOp-Prc interspace on a few individuals, presumably females; 1 specimen with a very small, indistinct supracaudal luminous patch at the same vertical is a male. In most specimens, even the largest ones, no caudal luminous patches are developed.

Color in alcohol pale brown with darker areas dorsally and at caudal base. Opercles and remaining scales of lateral and ventral regions with silvery reflections.

I have examined 28 specimens of this species from the following localities: Kogoshima Market, Japan, 20 specimens: Bulan Sorsogon, Luzon, Philippine Islands, 1 specimen (paratype of *Myctophum gilberti* Evermann and Seale); near Romblon, Philippine Islands, 7 specimens.

This species ranges through the warm regions of the Pacific and Indian Oceans from the Gulf of Panama to the Seychelles Islands, 4° 34' 08" S., Long. 85° 56' 05" E. In the eastern Pacific it has been taken as far north as Cape San Lucas, Lower California, Lat. 22° 50' 20" N., Long. 109° 48' 15" W., which brings it into the area discussed in this report. In the western Pacific it is known from southern Japan. There is still some doubt as to its occurrence in the Atlantic as reports from this region may be based upon erroneous identification of *Myctophum simile*.

Genus *DIOGENICHTHYS*, new

Genotype *Myctophum laternatum* Garman.

A single series of flattened lanceolate teeth on premaxillary; most of these teeth with a minute spine on each edge at its widest point, a number of the posterior teeth bent sharply forward, hook-like. Dentary teeth in a double series; the outer teeth set close together, flattened, leaf-like, wider than high, with a minute distal point; inner row similar to premaxillary teeth but much smaller and very widely spaced, usually without the lateral spines; the posterior teeth hooked forward. Two or 3 small cardiform teeth on each side of vomer, separated by a naked median area; a single irregular series of small cardiform teeth on palatines; a few scattered minute teeth on entopterygoids. Gill-rakers well developed. Dorsal base much shorter than anal; anal origin under or slightly in advance of end of dorsal base; pectoral base low, its upper end about twice as close to ventral body margin as to dorsal margin. Five PO, all in line; PLO far above pectoral base; 4 VO, the second elevated; 1 Pol; AO interspace over posterior end of anal base; 2 Prc, the second very little elevated. Luminous glands of caudal peduncle undivided, composed of a continuous sheet of tissue.

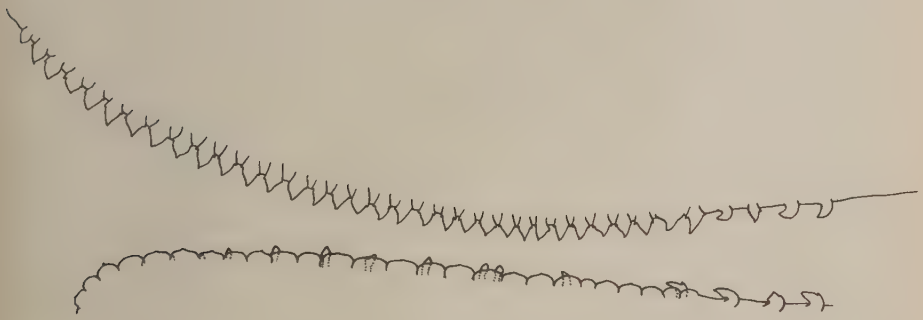

Fig. 14. *Diogenichthys laternatus* (Garman). Premaxillary and dentary dentition of the left side drawn from lateral view.

The elevated VO_2 found in the two species of this genus suggests relationship to the subgenus *Benthosema* of the genus *Myctophum*. However, the undivided luminous glands of the caudal peduncle and particularly the strikingly modified teeth present differences of such importance that it seems advisable to establish a new genus for these two species.

Diogenichthys laternatus (Garman)

Myctophum laternatum Garman, 1899, p. 267, pl. 56, fig. 1 (Albatross stations

3388, 3414 and 3437, off the Pacific Coast of Central America and the Gulf of California); Parr, 1931, p. 23, fig. 8.

Body robust throughout, narrowing abruptly under dorsal fin. Upper anterior profile of head evenly rounded or slightly flattened above eye; snout bluntly rounded, slightly protruding; mouth barely inferior. Posterior third of maxillary broadly expanded, its end bluntly rounded; extending a little beyond eye, about 0.2 or 0.3 of its length lying behind a perpendicular to mouth drawn through posterior margin of orbit. Eye large, orbital diameter about twice length of snout. Opercular margin evenly rounded. Gill-rakers long, those at angle equal to a little more than 0.5 diameter of orbit; 3 (3-4) + 1 + 10 on first arch, with one or two rudimentary ones on anterior end of each arm (5 specimens counted).

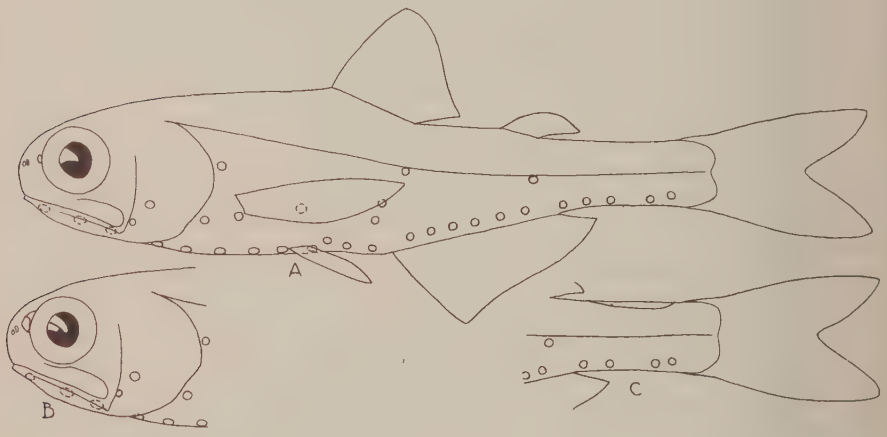

Fig. 15. *Diogenichthys laternatus* (Garman). A. Adult female. B. Head of adult male. C. Caudal peduncle of adult male.

Fin formula: D. 11 (11-12); A. 16 (16-18); P. 10 (10-12); V. 8. Dorsal origin midway between snout and a point somewhere between last AOp and Prc_2; dorsal base 1.8 (1.6-2.0) in anal base. Anal origin directly under or slightly in advance of end of dorsal base. Adipose fin well in advance of end of anal base. Pectoral base midway between snout and a point somewhere between AOa_1 and AOa_5; base of fin more nearly vertical than horizontal; fin extending to somewhere between AOa_1 and AOa_3. Ventral base midway between pectoral base and dorsal origin or slightly behind this point; fin extending about to anal origin. Scales cycloid, deciduous, almost entirely lost in all available specimens.

Measurements in percent of standard length based on 15 specimens, 11.9 to 25.1 mm. in standard length: length of head 31.5 (29.6-33.6); diameter of orbit 9.9 (8.5-10.9); length of maxillary 18.9 (17.0-20.4); distance from dorsal to

ventral 24.2 (22.1-26.3); distance from dorsal to anal 25.2 (23.0-27.6); depth of caudal peduncle 9.3 (8.3-10.6); distance from snout to dorsal 48.9 (44.6-51.0); length of dorsal base 13.9 (11.9-15.2); distance from snout to anal 57.8 (53.6-62.2); length of anal base 24.8 (23.1-27.9); distance from snout to adipose 72.9 (68.4-75.7); distance from snout to pectoral 34.0 (31.5-37.1); distance from snout to ventral 42.6 (38.7-45.4).

A well developed Dn, of moderate size in females and young, greatly enlarged in adult males, being equal to or larger than laminated rosette of nasal tissue and similar to enlarged organs of *Diaphus*. A small but well developed Op_1 opposite middle of maxillary expansion; Op_2 about the same size as general body photophores, approximately on level of middle of pectoral base, well behind Op_1 and separated from it by a space equal to about twice its own diameter. PLO usually slightly behind, rarely directly over or even slightly in front of PO_3, a little nearer pectoral base than lateral line. PVO_1 about over middle of second PO interspace, very slightly below level of PVO_2 which is at base of lower pectoral rays and somewhat in advance of PO_4. Five PO, about evenly spaced; PO_1 a little posterior to OP_2; from ventral view the first 4 pairs form slightly curved lines with the convexity directed outward; fifth pair abruptly divergent, located a little anterior to base of outer ventral ray. VLO about over middle of ventral base, somewhat nearer ventral base than lateral line, forming a straight line with the two PVO. Four VO about evenly spaced; VO_1 just posterior to base of inner ventral rays; VO_2 noticeably elevated but definitely not to a line passing through the two PVO; from ventral view the first, third and last pairs of organs form straight parallel lines or the third pair may be slightly divergent. SAO forming a very obtuse angle, its opening directed backward, or rarely arranged in a straight line; SAO_1 directly over or slightly behind VO_4, about on level of PVO_1; SAO_2 directly over or slightly in advance of anus, about twice as close to SAO_1 as to SAO_3 which is directly over or very slightly anterior to AO_1 and in contact with lateral line. Six (6-7) + 3 (2-4) AO, all in line, the first one or two interspaces often enlarged; AOp_1 directly over or somewhat behind base of last anal ray, separated from last AOa by a space equal to about 0.4 depth of caudal peduncle. Pol slightly behind last AOa, immediately below lateral line. Prc_1 near ventral body margin, separated from last AOp by an interspace about equal to 0.5 depth of caudal peduncle; Prc_2 very slightly elevated, much nearer ventral margin than lateral line, separated from Prc_1 by a space less than 0.5 as large as that between last AOp and Prc_1. Adult males with an undivided supracaudal luminous gland extending between verticals of next to last AOp and Prc_1. None of the specimens available shows any indication of infracaudal glands, although Brauer (1906) records a small infracaudal gland in the AOp-Prc interspace of a female specimen. However, his figure of this individual appears from the positions of the VO_2 and SAO_1 to be *Diogenichthys scofieldi*, although the arrangement of the Prc is typical of *D. laternatus*.

Color in alcohol a rather uniform brown throughout.

I have examined 15 specimens of this species from the following localities: off Santo Tomas Point, Lower California, Lat. 31° 33' N., Long. 117° 01' W., 1 specimen; off Cape Colnett, Lower California, Lat. 30° 35' N., Long. 117° 52' W., 7 specimens; off San Benito Islands, Lower California, Lat. 28° 12' N., Long. 116° 36' W., 6 specimens; off Kusakaki Shima, Japan, Lat. 30° 34' N., Long. 129° 22' E., 1 specimen.

The range of this species appears to encircle the globe between Latitudes 34° N. and 34° S. Several of the records, however, may possibly be based upon the

closely related *Diogenichthys scofieldi*, and its limits of distribution should be carefully checked.

Diogenichthys scofieldi, new species

Myctophum laternatum Gilbert, 1913, p. 77 (partim; some of the material re-examined); Tåning, 1918, p. 150, fig. 46.

Body robust throughout, narrowed abruptly under dorsal fin. Upper anterior profile of head rounded, somewhat flattened or even slightly concave above eye; snout blunt and steep but not protruding; mouth terminal. Posterior third of maxillary broadly expanded, its end bluntly rounded; extending about to vertical of hind edge of eye, about 0.2 of its length lying behind a perpendicular to mouth drawn through posterior margin of orbit. Eye large, orbital diameter about twice length of snout. Opercular margin ending in a blunt point. Gill-rakers long, those at angle equal to about 0.4 diameter of orbit; 2 + 1 + 10 (10-11) on first arch, with 1 or 2 rudimentary ones on the anterior end of each arm (4 specimens counted).

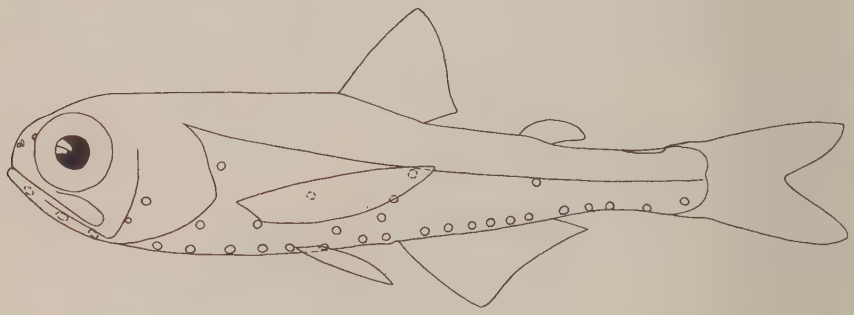

Fig. 16. *Diogenichthys scofieldi*, new species.

Fin formula: D. 11 (10-12); A. 16 (15-17); P. 14 (13-15); V. 8. Dorsal origin midway between snout and Prc_1 or Prc_2; dorsal base 1.8 (1.7-1.9) in anal base. Anal origin directly under or very slightly in advance of end of dorsal base. Adipose fin well in advance of end of anal base. Pectoral base midway between snout and a point somewhere between AOa_2 and AOa_5; base of fin more nearly horizontal than vertical; fin extending to AOa_2 or AOa_3. Ventral base about midway between pectoral base and dorsal origin; fin extending about to anal origin. Scales cycloid, deciduous, almost entirely lost in all available specimens.

Measurements in percent of standard length based on 7 specimens 14.1 to 17.7 mm. in standard length: length of head 31.0 (28.8-33.0); diameter of orbit 11.6 (10.7-12.4); length of maxillary 17.5 (16.3-18.4); distance from dorsal to

ventral 22.7 (21.2-23.5); distance from dorsal to anal 23.5 (22.9-24.1); depth of caudal peduncle 8.4 (7.9-8.8); distance from snout to dorsal 49.5 (48.0-55.3); length of dorsal base 13.0 (11.3-14.7); distance from snout to anal 59.5 (58.2-61.7); length of anal base 23.6 (21.7-25.6); distance from snout to adipose 73.7 (67.3-77.3); distance from snout to pectoral 34.4 (32.8-35.3); distance from snout to ventral 44.7 (43.6-45.4).

A well developed Dn. A small but well developed Op_1 opposite upper part of maxillary expansion; Op_2 about the same size as general body photophores, approximately on level of upper end of pectoral base, well behind Op_1 and separated from it by a space equal to about twice its own diameter. PLO usually slightly behind, rarely directly over or even slightly in front of PO_3, a little nearer lateral line than pectoral base. PVO_1 somewhat behind PO_2, about on same level or even a little higher than PVO_2 which is at base of lower pectoral rays and very slightly in advance of PO_4. Five PO about evenly spaced, PO_1 slightly posterior to Op_2; from ventral view the first four pairs of organs form gently curved lines with the convexity directed outward; fifth pair abruptly divergent, located a little anterior to base of outer ventral ray. VLO about over middle of ventral base, somewhat nearer lateral line than ventral base, about on a line between PLO and SAO_1 and far above a line through the two PVO. Four VO about evenly spaced; VO_1 just posterior to base of inner ventral rays; VO_2 elevated to such an extent that it forms a straight line with the two PVO; from ventral view the first, third and last pairs of organs form parallel straight lines or the third pair may be slightly divergent. SAO forming a straight line or very obtuse angle with its opening directed backward; SAO_1 directly over or slightly in advance of VO_4, some somewhat above level of VO_2; SAO_2 directly over or slightly in advance of anal origin, about twice as close to SAO_1 as to SAO_3 which is usually slightly anterior to but often directly over or even posterior to AO_1 and in contact with lateral line. Six (6-8) + 3 (3-4) AO all in line; first 1 or 2 interspaces usually enlarged; AOp_1 directly over or somewhat behind, rarely slightly in front of base of last anal ray, separated from last AOa by an interspace equal to about 0.3 or 0.4 depth of caudal peduncle. Pol slightly behind last AOa, immediately below lateral line. Prc_1 near ventral body margin separated from last AOp by an interspace about equal to that between last AOa and AOp_1; Prc_2 slightly elevated but much nearer ventral body margin than lateral line, separated from Prc_1 by a space fully as wide as that between last AOp and Prc_1. Adult males with an undivided supracaudal luminous gland extending from last AOp to slightly beyond Prc_1. No infracaudal glands on any of the types.

Color in alcohol uniform pale brown throughout. Fins pale.

The holotype (Stanford Natural History Museum no. 33657) is a male specimen 17.7 mm. in standard length from off Cortez Banks, Lat. 31° 33' N., Long. 119° 57' W., between 50 meters and the surface. Six paratypes, 14.1-17.0 mm. in standard length are from the following localities: off Point Buchon, California, Lat. 35° 05' N., Long. 123° 29' W., 2 specimens; 5.5 miles S. W. of Point Arguello, 1 specimen; off San Miguel Island, Lat. 33° 42' N., Long. 121° 24' W., 1 specimen; off southern California, Lat. 33° 05' N., Long. 122° 31' W., 1 specimen; off Kusakaki Shima, Japan, Lat. 30° 34' N., Long. 129° 22' E., 1 specimen.

The Japanese specimen was found in a bottle together with one specimen of *Diogenichthys laternatus*, and is part of the material upon which Gilbert (1913) reported under the name *Myctophum laternatum*. The holotype and four paratypes have been deposited in the collections of Stanford University, one paratype has been placed in the United States National Museum and another in the Museum of

Comparative Zoology at Harvard.

I take great pleasure in naming this species for Mr. Eugene C. Scofield, who, while in the employ of the California Division of Fish and Game, collected the American types.

Genus *DIAPHUS* Eigenmann and Eigenmann

Diaphus Eigenmann and Eigenmann, 1890, p. 3 (genotype by original designation *Diaphus theta* E. and E. = *Nychtophus rafinesquii* Cocco).
Collettia Goode and Bean, 1895, p. 88 (genotype by original designation *Nychtophus rafinesquii* Cocco).

Teeth in premaxillary in a rather poorly defined double series or narrow band; the anterior teeth small, fang-like; those under middle of eye developing more abruptly tapered points which are bent slightly forward; the inner series of teeth on the posterior half of the premaxillary have broad strong bases and very sharply recurved tips; smaller and straighter teeth occur laterally. Dentary

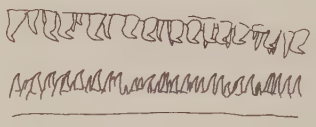

Fig. 17. *Diaphus rafinesquii* (Cocco). Premaxillary and dentary dentition of the left side drawn from internal view in order to show recurved teeth of inner premaxillary series. The portion of the jaws shown is about midway between hind margin of eye and end of maxillary.

teeth in a broad band; teeth similar in shape to the outer premaxillary series. Vomer naked or with a very few, widely spaced, irregularly scattered, minute teeth. A moderately narrow band of similar teeth on anterior half of palatines. A roughly oval patch of similar teeth on entopterygoids, the patch about as long and 3 or 4 times as wide as palatine band. Gill-rakers well developed. General body photophores divided by a slightly curved, horizontal, black septum; Dn enlarged and conspicuous but not extending to midline of snout; a well developed So, incompletely divided into 2 unequal parts; 5 PO, the fourth elevated; 5 VO, second and third elevated; 3 Prc. No supra- nor infracaudal luminous glands.

The limits of the genus *Diaphus* as diagnosed above are unknown although I presume that it will include *D. brachycephalus* Tåning. Probably most of the other species now placed in the genus will require re-allocation since examination of several forms has failed to reveal a dentition similar to that found in *Diaphus rafinesquii*.

Diaphus rafinesquii (Cocco)

Nychtophus rafinesquii Cocco, 1838, p. 20 (San Raineri).
Nyctophus rafinesquii Cocco, 1838, pl. 3, fig. 7.
Myctophum rafinesquii Bonaparte, 1840, fasc. 139, fig. 2.
Scopelus rafinesquii Cuvier and Valenciennes, 1849, p. 444.
Diaphus theta Eigenmann and Eigenmann, 1890, p. 4 (off Point Loma, California, from rock-cod mouths).
Myctophum protoculus Gilbert, 1890, p. 52 (Albatross station 3072, off Cape Johnson, Washington).
Scopelus (Nyctophus) rafinesquii Lütken, 1892, p. 258, fig. 17.
Scopelus protoculus Lütken, 1892, p. 266.
Collettia rafinesquii Goode and Bean, 1895, p. 88, pl. 26, fig. 100.
Myctophum (Nyctophus) theta Brauer, 1904, p. 393.
Myctophum (Nyctophus) rafinesquii Brauer, 1904, p. 393.
Myctophum (Diaphus) rafinesquii Brauer, 1906, p. 223, figs. 144-145.
Myctophum (Diaphus) theta Brauer, 1906, p. 157.
Diaphus nanus Gilbert, 1908, p. 224, pl. 1 (Albatross hydrographic station 3798, near Nukuhiva Island, Marquesas).
Diaphus rafinesquii Gilbert, 1913, p. 91.
Diaphus holti Tåning, 1918, p. 88, fig. 35 (shore near Messina, Mediterranean Sea, and Bay of Cadiz).
Scopelus raffinesque Weill, 1926, p. 472.
Diaphus mollis Tåning, 1928, p. 60 (North Atlantic).
Diaphus protoculus Parr, 1929, p. 3.

Body heavy, dorsal and ventral contours roughly parallel anterior to dorsal origin, narrowing rather abruptly under dorsal fin; caudal peduncle heavy. Upper anterior profile of head flattened or slightly concave above eyes; snout truncate and somewhat protruding; mouth barely inferior. Maxillary not at all expanded posteriorly; extending well beyond eye, about 0.4 of its length lying behind a perpendicular to mouth drawn through posterior margin of orbit, slightly shorter than this in Japanese specimens. Eye large, orbital diameter 1.9 to 2.3 times length of snout. Opercular margin bluntly and evenly rounded. Gill-rakers long, slender, those at angle about 0.6 diameter of orbit; 6 (5-7) + 1 + 14 (11-15), on first arch (9 specimens counted), more numerous in California specimens than in Japanese.

Fin formula: D. 13 (12-14); A. 13 (13-14); P. 10 (10-11); V. 8. Dorsal origin midway between snout and a point somewhere between third and last AOp; dorsal base equal to or slightly longer than anal base. Anal origin under or slightly behind end of dorsal base. Adipose directly over or somewhat behind end of anal base. Pectoral base midway between snout and a point somewhere between VO_3 and anal origin; fin extending about to ventral base. Ventral base almost directly under dorsal origin; fin extending to or slightly beyond anal origin. Scales cycloid; 34-35 in lateral line.

Measurements in percent of standard length, based on 15 specimens 14.1 to 65.6 mm. in standard length: length of head 31.4 (28.9-34.8); diameter of orbit 10.2 (9.4-10.8); length of maxillary 20.6 (17.1-23.0); distance from dorsal to ventral 23.2 (21.7-25.5); distance from dorsal to anal 29.8 (26.9-31.8); depth of caudal peduncle 11.2 (9.7-12.7); distance from snout to dorsal 47.5 (44.4-

50.0); length of dorsal base 17.3 (13.5-19.3); distance from snout to anal 66.0 (62.4-68.1); length of anal base 14.5 (12.9-16.0); distance from snout to adipose 80.2 (77.4-82.3); distance from snout to pectoral 31.4 (27.3-34.0); distance from snout to ventral 42.8 (41.0-45.4).

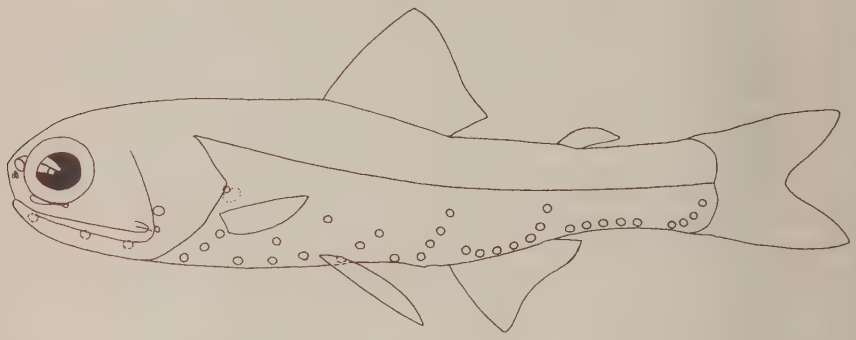

Fig. 18. *Diaphus rafinesquii* (Cocco).

A large Dn entirely above nostrils and extending not quite to median ethmoid ridge, about equal in size to laminated rosette of nasal tissue which can easily be seen through transparent terminal portion of snout. An imperfectly divided So, the anterior portion large and elongate, under anterior part of eye, connected by a strand of black pigment to the small round posterior part located under hind part of pupil. Op_1 small, opposite end of maxillary; Op_2 about size of general body organs, on or slightly above level of upper end of pectoral base, separated from Op_1 by an interspace about equal to its own diameter. PLO directly over or slightly behind base of upper pectoral ray, usually about twice as close to fin as to lateral line but sometimes higher. PVO_1 well behind PO_1, about midway between it and PVO_2 or slightly closer to the latter organ which is at base of lower pectoral rays, the 3 organs forming a straight line. Five PO; PO_4 elevated so that it falls on or just above a line between upper pectoral and outer ventral rays, advanced to a position almost directly over PO_3 in California specimens, slightly behind PO_3 in material from Japan; PO_1 well behind Op_2; first PO interspace about twice as wide as second which is about equal to that between PO_3 and PO_5; from ventral view the first 3 organs form gently diverging straight or slightly curved lines with the convexity directed outward; PO_5 more widely divergent, located just antero-mesad to base of outer ventral ray. VLO directly over or slightly behind base of outer ventral rays, midway between fin and lateral line in Japanese specimens, usually slightly lower in California material. Five VO; VO_1 directly mesad to base of inner ventral rays; next two organs progressively elevated, forming an ascending straight line with the first, about evenly spaced, VO_3 about on level of SAO_1 or SAO_2; last 2 VO on level of, and forming parallel straight lines with, VO_1; last interspace about equal to first

one. SAO forming a slight arc of 3 equally spaced organs in California specimens; SAC_1 over and slightly posterior to VO_5; SAO_2 somewhat higher and about over anus; SAO_3 about over anal origin and 2 or 3 diameters below lateral line; in Japanese specimens the SAO_3 is separated from SAO_2 by an interspace about twice as wide as that between SAO_1 and SAO_2 and is scarcely more than 1 diameter below lateral line. Four (4-5) + 6 (4-7) AO; the California specimens averaging one more AOp (usually 6) than Japanese specimens (usually 5); AOa_1 not at all or but very slightly elevated in California material, usually strongly elevated, sometimes to level of SAO_2 in Japanese specimens; last AOa strongly elevated, the terminal part of the series curved up toward Pol; AOp_1 well behind anal base, separated from last AOa by an interspace equal to about 0.2 depth of caudal peduncle. One Pol somewhat behind last AOa and about midway between it and lateral line in California specimens, much nearer lateral line than last AOa in Japanese specimens. Four Prc; Prc_1 near ventral body margin, separated from last AOa by an interspace somewhat greater than that between last AOa and first AOp; all organs forming an ascending arc with first 2 interspaces about equal, the third enlarged; Prc_4 about 2 or 3 diameters below lateral line. A luminous gland immediately postero-ventral to PLO, sometimes difficult to distinguish.

Color dark blue with blackish dorsal area; the scales reflecting metallic tones. Fins pale.

Several minor differences between California and Japanese specimens have been noted. These and similar differences which may distinguish local populations of the same species in the Atlantic have been discussed at considerable length by Parr (1928 and 1929a), who presents strong evidence in support of his view that the subdivision of these forms into entirely separate species is impracticable. I tentatively accept these views.

I have examined 23 specimens of *Diaphus rafinesquii*, 11.0 to 65.6 mm. in standard length, from the following localities: off Central Washington, Lat. 47° 28' 30" N., Long. 125° 24' 00" W., 1 specimen (cotype of *Myctophum protoculus*); off Point Arena, California, Lat. 39° 02' 40" N., Long. 124° 06' 15" W., 5 specimens; off Monterey Bay, Lat. 36° 40' 30" N., Long. 122° 06' 00" W., 1 specimen; Lat. 36° 39' N., Long. 122° 02' W., 2 specimens; from stomach of *Germo alalunga*, Monterey markets, 1 specimen; off Carmel, Lat. 36° 35' N., Long. 122° 11' W., 1 specimen; San Pedro Channel, Lat. 33° 33' N., Long. 118° 23' W., 2 specimens; off southern California, Lat. 33° 05' N., Long. 122° 31' W., 1 specimen; off Ua-huka Island, Marquesas, 3 specimens (cotypes of *Diaphus nanus*); off Ose Saki, Japan, Lat. 35° 02' 10" N., Long. 138° 37' 50" E., 4 specimens; off Kusakaki Jima, Lat. 30° 34' N., Long. 129° 22' E., 1 specimen; Messina, Italy, 1 specimen.

This species is widely distributed in temperate waters of the Atlantic and Pacific. On the western coast of North America it has been reported from numerous stations between Sitka, Alaska, and San Diego, California.

Genus *LAMPANYCTUS* Bonaparte

Lampanyctus Bonaparte, 1840, fasc. 139 (genotype by monotypy *Nyctophus bonapartii* Cocco = *Gasteropelecus crocodilus* Risso).

Serpe Cuvier and Valenciennes, 1849, p. 430.

Ceratoscopelus Günther, 1864, p. 405 (as a subgenus; genotype by monotypy *Scopelus maderensis* Lowe).

Nannobrachium Günther, 1887, p. 199 (genotype by monotypy *Nannobrachium nigrum* Günther).

Stenobrachius Eigenmann and Eigenmann, 1890, p. 5 (as a subgenus; genotype by original designation *Myctophum leucopsarum* E. and E.).
Nanobranchium Goode and Bean, 1895, p. 94 (*lapsus calami*).
Nannobranchium Goode and Bean, 1895, p. 94 (*lapsus calami*).
Nyctimaster Jordan, 1921, p. 645 (genotype by original designation *Lampanyctus jordani* Gilbert).
Nannabrachium Jordan, 1921, p. 645 (*lapsus calami*).
Panyctus (err. typ.) Parr, 1928b, p. 57.
Serpa Whitley, 1933, p. 64 (genotype by original designation *Gasteropelecus crocodilus* Risso).

Recently Whitley (1933) has introduced the generic name *Serpa* as a substitute for *Lampanyctus* with the following explanation: "Most authors use *Lampanyctus* as the name of this genus, but *Macrostoma* and *Serpa* are earlier. *Macrostoma* is preoccupied, so *Serpa* should apparently be used. This name was proposed by Cloquet for the 'Serpe' of Risso, including two species, *Scopelus crocodilus* and *S. humbolti* (Risso) Cloquet. I select *Scopelus crocodilus* as the logotype of *Serpa*."

The entire matter is in need of some clarification. It so happens that *Macrostomus* Wiedeman, 1817 (Diptera) does not invalidate *Macrostoma* Risso, 1826. This type of problem is fully discussed in the recommendations under Article 36 of the International Rules of Zoological Nomenclature with exactly parallel examples of names (*Picus, Pica; Polyodonta, Polyodontus*) which are not to be rejected because of similarity. However, since the name is occasionally used for lantern fishes even today (Barnhart, 1936; Fowler, 1938), it should be pointed out that, while *Macrostoma* is valid in ichthyology, it appears to be unusable in the family Myctophidae.

Jordan and Evermann (1896) seem to have been responsible for the introduction of the name into the literature of the Myctophidae. This introduction was based upon the evidently false opinion that *Scopelus elongatus* Costa and *Lampanyctus resplendens* Richardson were synonyms of *Macrostoma angustidens* Risso. In the generic diagnosis of *Macrostoma*, Risso (1826) records the occurrence of teeth on the maxillary. That this statement, which should be enough to exclude the fish from the Myctophidae, is not based on an error of observation or interpretation is indicated by the fact that in the same work Risso clearly and correctly states that *Scopelus* has the entire margin of the upper jaw formed by the premaxillary. Further, Risso deliberately removed *Macrostoma angustidens*, which he had originally described (1820) under the name *Scopelus angustidens*, from the lantern fishes and placed it in the entirely different group "Les Clupéoides." Under these circumstances and since it does not agree at all in body proportions with Costa's *Scopelus elongatus*, it seems probable that this fish is in reality a Clupeid, and practically certain that the generic name can not be applied to a Myctophid. The dubious status of *Macrostoma* militates against its use.

In regard to the other part of the problem, I fail to see that *Serpa* had any nomenclatural validity whatsoever until introduced by Whitley. Instead of the name being proposed by Cloquet (1827) as a Latin name, it was used by him (except in the specific synonymy) as the vernacular French "Serpe" in the same manner as it had previously been used by Risso (1810).[1] Cloquet discussed the fishes under the heading: "SCOPELE, *Scopelus. (Ichthyol.)*." The individual species are listed as "Le SCOPÈLE CROCODILE: *Scopelus crocodilus* N.; *Serpa croco-*

[1]And by Lacépède (1803) - Editor.

dilus, Risso," and "Le SCOPÈLE HUMBOLDT: *Scopelus Humboldti*, N.; *Serpa Humboldti*, Risso." It seems evident that *"Serpa crocodilus"* and *"Serpa Humboldti"* were considered by Cloquet as synonyms. Further, "Serpa" in these cases is a patent misquotation since Risso never used the name in this form. He listed his fishes as *"S. Microstoma," "S. Crocodilus"* and *"S. Humboldti"* under a generic heading that gave Serpe as the common name and *Gasteropelecus* as the scientific name. The *"S."* was evidently an error, conflicting with the Latin generic heading and also with the index. Under these circumstances it appears that *Serpa*, based only on an error misquoted as a synonym, can hardly have achieved good nomenclatural status. *Serpe* has, on the other hand, been used several times as a generic name coupled with Latin specific names (Cuvier and Valenciennes, 1849; Doderlein, 1882), but apparently not prior to the establishment of *Lampanyctus* in 1840. It seems better to avoid the substitution of the highly questionable name *Serpa* for one in good current use. I, therefore, retain *Lampanyctus*.

Some 60 known species belong to this genus as it is ordinarily understood today. These group themselves into several minor aggregates of species which, however, are not clearly defined. There has evidently been a great deal of extraspecific recurrent mutation within the group, which has complicated the picture to an extraordinary degree. Totally different evolutionary patterns are indicated when the importance of different characters is stressed, and since so many species and so many varying characters are involved, the number of possible patterns is very great. I have considered it best to ignore for the present most of these problems although division of the group into several subgenera, or even genera, would be desirable. It has, however, been possible on the basis of many characters to separate five species as the divergent genus *Notoscopelus* (see page 150).

The remaining forms may be diagnosed as follows: mouth large, extending far beyond orbit; narrow bands of small cardiform teeth on premaxillaries and dentaries; vomer with one or a very few similar teeth on each side, its median part naked; a single series or narrow band of small teeth on palatines; a large oval patch of minute scattered teeth on entopterygoids. Gill-rakers well developed. Lateral line present, complete. Dorsal fin equal to or shorter than anal. No enlarged Dn photophore; 1 to 3 Pol, not all in a horizontal series if more than 1 present; AO in 2 groups separated by an enlarged interspace; 3 to 9 Prc, often directly continuous with AOp (counted as 4 when continuous); supra- and infracaudal glands both present, except in *Lampanyctus nicholsi* Gilbert and *L. braueri* (Lönnberg), divided into units corresponding to the scales but never outlined by black pigment, the division often obscure.

Lampanyctus leucopsarus (Eigenmann and Eigenmann)

Myctophum (Stenobrachius) leucopsarum Eigenmann and Eigenmann, 1890, p. 5 (from mouths of *Sebastodes* taken off Point Loma, California).
Myctophum nannochir Gilbert, 1890, p. 51 (partim).
Nannobrachium leucopsarum Gilbert, 1895, p. 399.
Stenobrachius leucopsarum Goode and Bean, 1895, p. 512.
Myctophum leucopsarum Goode and Bean, 1895, p. 512.
Myctophum (Lampanyctus) leucopsarum Brauer, 1904, p. 396; 1906, p. 238, fig. 156.
Lampanyctus leucopsarum Gilbert, 1913, p. 100.
Lampanyctus leucopsarus Parr, 1928, p. 86.
Nannobranchium leucopsarum Taranetz, 1937, p. 69 *(lapsus calami)*.

Body moderately robust, dorsal and ventral contours roughly parallel anterior to dorsal origin, abruptly narrowing under dorsal and then tapering evenly to caudal peduncle. Upper anterior profile flattened or even slightly concave above eyes; snout steep, blunt; mouth terminal. Maxillary very slightly but abruptly expanded posteriorly; extending far beyond eye, about 0.4 of its length lying behind a perpendicular to mouth drawn through posterior margin of the orbit. A few minute teeth on each side of vomer; palatine teeth in a narrow band. Eye moderate in size, orbital diameter about 1.5 times length of snout. Opercular margin ending in a sharp point. Gill-rakers long, slender, those at angle equal to about 0.7 diameter of orbit; 6 (5-6) + 1 + 12 (11-12) on first arch, preceded by 1 or 2 rudimentary ones on each limb (10 specimens counted).

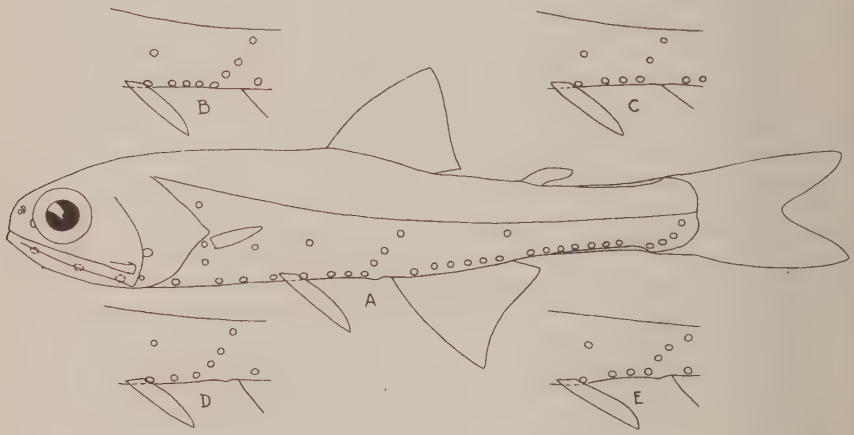

Fig. 19. *Lampanyctus leucopsarus* Eigenmann and Eigenmann. A. Adult male. B., C., D. and E. Abdominal region of specimens varying in VO and SAO photophores.

Fin formula: D. 14 (13-15); A. 15 (14-16); P. 9 (8-10); V. 8 (8-9). Dorsal origin midway between snout and a point somewhere between AOp_5 and Prc_3, tending to be more advanced in northern than in southern specimens; dorsal base 1.1 (1.0-1.2) in anal base. Anal origin well in advance of end of dorsal base (under ninth to eleventh dorsal ray). Adipose slightly posterior to end of anal base. Pectoral base midway between snout and a point somewhere between SAO_2 and AOa_2; fin extending to somewhere between PO_3 and PO_5. Ventral base about twice as close to dorsal origin as to pectoral base; fin extending to somewhere between VO_4 and anal origin. Scales cycloid; 36-38 in lateral line.

Measurements in percent of standard length based on 58 specimens 17.4 to 88.0 mm. in standard length: length of head 30.4 (26.3-32.8); diameter of orbit 8.1 (6.5-9.3); length of maxillary 20.4 (17.8-23.6); distance from dorsal to ventral 19.9 (16.3-22.9); distance from dorsal to anal 22.5 (19.7-25.2); depth of

caudal peduncle 9.7 (6.9-11.8); distance from snout to dorsal 47.8 (40.4-49.6); length of dorsal base 15.9 (14.6-17.9); distance from snout to anal 58.0 (52.8-60.6); length of anal base 17.4 (15.8-19.8); distance from snout to adipose 77.1 (75.3-79.8); distance from snout to pectoral 30.3 (26.0-33.0); distance from snout to ventral 42.5 (39.7-44.9).

A well developed but deeply embedded Vn. Op_1 small, a little below and behind posterior end of maxillary; Op_2 slightly larger than neighboring organs, on or slightly below level of PVO_2, and a little behind Op_1. PLO slightly in advance of PVO_2, usually about twice as close to lateral line as to pectoral base, often slightly lower. PVO_1 well in front of PO_2, about under PVO_2 and midway between ventral body margin and base of upper pectoral rays; PVO_2 just in advance of pectoral base, usually slightly above its middle. Five PO (6 on 1 side of 1 specimen); PO_4 usually slightly in advance of middle of PO_3-PO_5 interspace, strongly elevated, a line through VLO and PO_4 passing between the 2 PVO or sometimes through PVO_2; PO_1 on vertical about midway between Op_2 and PVO_2; first PO interspace markedly wider than second which is equal to or slightly smaller than that between PO_3 and PO_5; from ventral view the 4 lower organs form slightly diverging straight lines; PO_5 located just antero-mesad to base of outer ventral rays. VLO slightly behind, rarely directly over or even slightly in front of VO_1, about midway between ventral body margin and lateral line. Four (3-5) VO, variations from normal not uncommon. Of 133 specimens counted, 9 had 3 organs on both sides, 14 had 3 on one side, 3 had 5 on one side and 1 had 5 on both sides. Since 2 of these specimens had 3 organs on one side and 5 on the other, 25 individuals or 18.8% varied from the normal. VO_1 just behind and very slightly mesad to base of middle ventral rays; first VO interspace usually largest, others subequal; from ventral view all organs form slightly curved lines with the convexity directed outward or the last organ is sometimes a little divergent, appearing as the lower SAO. SAO very variable, counted as 3 although often continuous with VO and appearing to consist of 2 or 4 organs; forming a straight line or obtuse angle with the opening directed either forward or backward; SAO_1 usually over and slightly behind last VO, sometimes directly behind it; SAO_2 directly over or slightly in advance of anal origin, slightly nearer SAO_1 than SAO_3 which is about its own diameter or slightly more below lateral line and on a vertical somewhere between anal origin and AO_1. Six (5-7) + 7 (6-8) AO; AO_1 often slightly depressed and separated from AO_2 by a somewhat enlarged interspace; AOp_1 well behind end of anal base, separated from last AOa by an interspace equal to 0.2 or 0.3 depth of caudal peduncle. Only 1 Pol, over last or next to last anal ray, about its own diameter below lateral line. Four, rarely 3 or 5 Prc; Prc_1 usually separated from last AOp by an interspace about equal to that between last AOa and AOp_1, but this space may be somewhat greater or reduced to the extent that the AOp and Prc series are continuous; Prc arranged in an ascending arc; the last one or sometimes two interspaces somewhat enlarged; Prc_4 about its own diameter below lateral line. Five to 8 supracaudal luminous glands extending from vertical of third, fourth or fifth AOp to Prc_1 or Prc_2; 7 to 9 similar infracaudal glands extending from first or second AOp to Prc_1.

The difficulty of differentiating between the VO and SAO organs in some individuals of this species (figs. 19c and 19d) brings up the problem of photophore terminology. Parr (1929a) claims that the type specimen has no VLO but has "5 VO, the second being elevated and advanced to a position nearly vertically above the first VO." It should be pointed out that it is entirely possible that all of the elevated organs have been derived from a primitively ventral and

strictly linear series. This is strongly indicated by the universally recognized elevation of the PO_4 and some of the VO in many species; by the practical continuity of the VO and SAO and the occurrence of the later organs over a gap in the ventral series, as in the present species; by the frequent elevation of the anterior AO which tends to connect this series with the SAO in the genus *Diaphus*; by the frequent practical continuity of the AOa and Pol, together with the occurrence of the latter organs over the AO interspace and their absence when the AO forms a continuous series as in the genus *Electrona*; and by the marked elevation of some of the posterior Prc in some forms while they are little elevated in others. The normal VLO is probably an elevated posterior PO or anterior VO. However, since no one has determined definitely the homologies of the various elevated photophores, it seems advisable to continue to call the organ above the VO_1 a VLO by virtue of its position, which seems to approximate most closely that of the VLO of related forms.

Color light steely blue along sides and ventral surfaces, dorsal region purplish; fins pale. The color darkens markedly in alcohol. In life the caudal glands emit a strong blue light. According to Gilbert (1915) the photophores are golden yellow in life, differing from those of *Lampanyctus nannochir* which are claret color.

I have examined 156 specimens of *Lampanyctus leucopsarus*, 17.4 to 88.0 mm. in standard length, from the following localities: Bering Sea, Lat. 56° 12' N., Long. 172° 07' W., 1 specimen; Lat. 53° 55' N., Long. 170° 50' W., 2 specimens; off central Washington, Lat. 47° 28' 30" N., Long. 125° 24' 00" W., 2 specimens; off Cape Mendocino, California, Lat. 40° 21' N., Long. 124° 45' W., 10 specimens; off Point Arena, Lat. 39° 02' 40" N., Long. 124° 06' 15" W., 1 specimen; off Point Reyes, Lat. 37° 50' N., Long. 123° 25' W., 3 specimens; off Monterey Bay, Lat. 36° 49' N., Long. 122° 02' W., 1 specimen; Lat. 36° 47' N., Long. 122° 03' W., 1 specimen; Lat. 36° 45' N., Long. 122° 10' 20" W., 6 specimens; Lat. 36° 45' N., Long. 122° 03' W., 8 specimens; Lat. 36° 44' N., Long. 122° 01' W., 9 specimens; Lat. 36° 43' N., Long. 122° 02' 30" W., 2 specimens; Lat. 36° 41' N., Long. 122° 18' W., 1 specimen; Lat. 36° 41' N., Long. 122° 02' W., 1 specimen; Lat. 36° 40' 30" N., Long. 122° 06' W., 3 specimens; Lat. 36° 40" 15" N., Long. 122° 05' W., 3 specimens; Lat. 36° 40' 05" N., Long. 122° 03' 45" W., 1 specimen; Lat. 36° 40' N., Long. 122° 30' W., 8 specimens; Lat. 36° 40' N., Long. 122° 07' W., 1 specimen; Lat. 36° 40' N., Long. 122° 03' W., 2 specimens; Lat. 36° 39' N., Long. 122° 33' W., 3 specimens; Lat. 36° 39' N., Long. 122° 02' W., 5 specimens; Monterey Bay, 3 specimens; off Carmel, Lat. 36° 35' N., Long. 122° 11' W., 2 specimens; off Point Sal, Lat. 34° 55' N., Long. 122° 35' W., 1 specimen; Santa Barbara Channel, Lat. 34° 15' N., Long. 119° 50' W., 4 specimens; off Santa Cruz Island, Lat. 33° 40' N., Long. 119° 32' W., 19 specimens; off Santa Rosa Island, Lat. 33° 35' N., Long. 120° 20' W., 1 specimen; San Pedro Channel, Lat. 33° 42' N., Long. 118° 25' W., 1 specimen; Lat. 33° 33' N., Long. 118° 23' W., 34 specimens; Lat. 33° 28' 30" N., Long. 118° 21' 30" W., 10 specimens; Santa Catalina Island, from stomach of *Sebastodes sp.*, 1 specimen; Outer Santa Barbara Passage, Lat. 33° 11' N., Long. 118° 21' 30" W., 5 specimens; no data, 1 specimen.

The known range of this species is from the eastern part of Bering Sea, Lat. 56° 12' N., Long. 172° 07' W., to San Diego, California.

Lampanyctus leucopsarus has as its closest relatives *L. nannochir* (Gilbert) and *L. beringensis* Schmidt, if indeed the latter form, from the region of Bering Island and Cape Olutorsky, Kamchatka, is distinct from *L. leucopsarus*. These species form a very well circumscribed line of evolution characterized by

having the dorsal fin very little shorter than anal; adipose well behind end of anal base; anal origin well in advance of end of dorsal base; pectoral very small; ventral base well in advance of dorsal origin; a well developed Vn; no Bu; no Ce; PVO_2 opposite pectoral base and PVO_1 almost directly under it; PO_4 elevated and slightly advanced; VLO rather far posterior; VO in line; SAO very weakly angulated; AO interspace over end of anal base; only a single Pol; and no luminous glands except on caudal peduncle.

Lampanyctus nannochir (Gilbert)

Myctophum nannochir Gilbert, 1890 (partim; type locality designated by Gilbert, 1895, as Albatross station 3072, off central Washington).
Scopelus nannochir Lütken, 1892, p. 266.
Nannobrachium nannochir Gilbert, 1895, p. 400.
Lampanyctus nannochir Gilbert, 1913, p. 100; Parr, 1929a, p. 18, fig. 8.
Nannobranchium nannochir Taranetz, 1937, p. 69 *(lapsus calami)*.

Body moderately robust, tapering rather evenly from nape to caudal peduncle but narrowing somewhat more abruptly under dorsal and adipose fins. Upper anterior profile flattened above eyes; snout steep, moderately blunt; mouth terminal. Maxillary very slightly but rather abruptly expanded posteriorly; extending far beyond eye, about 0.5 of its length lying behind a perpendicular to mouth

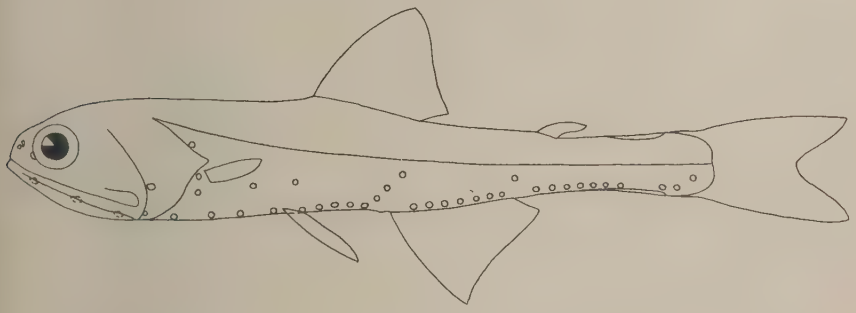

Fig. 20. *Lampanyctus nannochir* (Gilbert).

drawn through posterior margin of orbit. A few minute teeth on each side of vomer; palatine teeth in a narrow band. Eye moderate in size, orbital diameter about 1.1 or 1.2 times length of snout. Opercular margin ending in a sharp point. Gill-rakers long, slender, those at angle equal to about 0.9 diameter of orbit; 6 (5-6) + 1 + 11 (10-12) on first arch, preceded by 1 or 2 rudimentary ones on each limb (5 specimens counted).

Fin formula: D. 14 (13-14); A. 15 (14-16); P. 9 (9-10); V. 8. Dorsal ori-

gin midway between snout and last or next to last AOp; dorsal base 1.1 (1.0-1.2) in anal base. Anal origin well in advance of end of dorsal base (under ninth to eleventh dorsal ray). Adipose somewhat posterior to end of anal base. Pectoral base midway between snout and a point somewhere between anal origin and AOa_1; fin extending to somewhere between PO_3 and PO_5. Ventral base about twice as close to dorsal origin as to pectoral base; fin extending to somewhere between PO_4 and anus. Scales entirely lost in all available specimens.

Measurements in percent of standard length based on 16 specimens 58.1 to 106.6 mm. in standard length: length of head 30.0 (28.4-32.6); diameter of orbit 6.6 (5.8-7.5); length of maxillary 20.9 (19.3-22.2); distance from dorsal to ventral 17.6 (16.0-19.5); distance from dorsal to anal 21.1 (19.7-22.2); depth of caudal peduncle 7.9 (6.9-9.2); distance from snout to dorsal 45.9 (43.2-47.8); length of dorsal base 15.9 (13.5-17.7); distance from snout to anal 57.8 (54.4-60.8); length of anal base 17.5 (15.8-18.9); distance from snout to adipose 77.5 (75.6-79.8); distance from snout to pectoral 30.0 (28.8-32.3); distance from snout to ventral 41.1 (37.4-44.7).

A well developed but deeply embedded Vn. Op_1 small, a little below and behind posterior end of maxillary; Op_2 about the same size as neighboring organs, slightly below level of PVO_2 and a little behind Op_1. PLO slightly in advance of PVO_2, much nearer lateral line than pectoral base. PVO_1 well in front of PO_2, about under PVO_2, slightly closer to base of upper pectoral ray than ventral body margin; PVO_2 just in advance of pectoral base, usually slightly above its middle, on or slightly behind a line connecting PLO and PVO_1, definitely above a line between Op_2 and VLO. Five PO; PO_4 usually slightly in advance of middle of PO_3-PO_5 interspace, strongly elevated, a line through VLO and PO_4 passing through or slightly below, rarely slightly above PVO_1 (on 1 side of 1 specimen the PO_4 is small and not elevated, occurring in line between PO_3 and PO_5); PO_1 on a vertical midway between Op_2 and PVO_2 or slightly in advance of this point; first PO interspace larger than second, about equal to that between PO_3 and PO_5; from ventral view the 4 lower organs form slightly diverging straight lines, PO_5 located just antero-mesad to base of outer ventral rays. VLO slightly anterior to, rarely directly over or even slightly behind VO_1, about midway between ventral body margin and lateral line. Five, rarely 4, VO, all interspaces about equal; VO_1 just behind and very slightly mesad to base of middle ventral rays; from ventral view all organs form parallel straight lines. SAO forming a straight line or slight arc with VO_5; SAO_1 about over anus and a little above last VO; SAO_2 slightly higher, a little in advance of anal origin, slightly nearer SAO_1 than SAO_3 which is about 2 diameters below lateral line and a little in advance of AOa_1. Seven (6-8) + 6 (6-7) AO; AOa_1 sometimes slightly depressed, seldom followed by an enlarged interspace; AOp_1 well behind end of anal base separated from last AOa by an interspace equal to from 0.3 to 0.5 depth of caudal peduncle. Only 1 Pol, directly over or slightly behind base of last anal ray, usually more than its own diameter below lateral line. Three, rarely 4 Prc; Prc_1 separated from last AOp by a space somewhat greater than that between last AOa and AOp_1, the Prc arranged in an ascending arc; last interspace somewhat enlarged; last Prc a little more than its own diameter, often 2 diameters below lateral line. Two to 4 supracaudal luminous glands extending from about vertical of next to last AOp to somewhere between middle of AOp-Prc interspace and Prc_2; 5 or 6 similar infracaudal glands extending between third or fourth AOp and Prc_1.

Although this species is very close to *Lampanyctus leucopsarus*, it may be distinguished by several minor differences. These are the somewhat more slen-

ler body; the slightly smaller eye; the increased posterior extension of the maxillary; the normal occurrence of 5 VO and 3 Prc instead of 4 VO and 4 Prc, the slightly more advanced position of the VLO, the lower level of the PO_4, SAO_3, Pol and last Prc; the greater average number of AOa and the shorter supra- and infracaudal luminous areas.

I have examined 16 specimens of this species, all in rather poor condition, from the following localities: Bering Sea, Lat. 53° 55' N., Long. 170° 50' W., 1 specimen; off Unalaska Island, Lat. 53° 43' 40" N., Long. 167° 29' 30" W., 3 specimens; off central Washington, Lat. 47° 28' 30" N., Long. 125° 24' W., 9 specimens (the type and 8 paratypes); west coast of America, 3 specimens.

Lampanyctus nannochir ranges from the Okhotsk Sea off Cape Patience, Sakhalin Island, to off Point Arena, California, Lat. 39° 02' 40" N., Long. 124° 06' 15" W.

Lampanyctus mexicanus (Gilbert)

Myctophum mexicanum Gilbert, 1890, p. 51 (Albatross stations 3008 and 3009, in the Gulf of California).
Scopelus mexicanus Lütken, 1892, p. 266.
Nannobrachium mexicanum Goode and Bean, 1895, p. 512.
Myctophum oculeum Garman, 1899, p. 260, pl. 56, fig. 2 (numerous stations off the Pacific coast of Mexico and Central America).
Myctophum (Lampanyctus) mexicanum Brauer, 1904, p. 396.
Myctophum (Lampanyctus) oculeum Brauer, 1906, p. 167.
Lampanyctus mexicanus Parr, 1928, p. 84; 1931, p. 30, fig. 12.
Lampanyctus oculeus Parr, 1928, p. 85.

Body slender, dorsal and ventral contours roughly parallel anterior to dorsal origin, narrowing rather abruptly under dorsal base and then tapering evenly to caudal peduncle. Upper anterior profile very gently curved or entirely flat above eyes; snout bluntly pointed; mouth terminal. Maxillary slightly but very abruptly expanded posteriorly; extending far beyond eye, about 0.6 of its length lying behind a perpendicular to mouth drawn through posterior margin of orbit. A few teeth on each side of vomer; palatine teeth in a narrow band. Eye rather small, orbital diameter 1.0 to 1.3 times length of snout. Opercular margin ending in a moderately sharp point. Gill-rakers long, slender, those at angle equal to about 0.7 diameter of orbit; 4 + 1 + 11 (10-13) on first arch (10 specimens counted).

Fin formula: D. 14 (13-16); A. 15 (14-17); P. 9 (8-10); V. 8 (7-9). Dorsal origin midway between snout and a point somewhere between last AOp and Prc_3; dorsal base 1.2 (1.1-1.3) in anal base. Anal origin well in advance of end of dorsal base (about under ninth to eleventh dorsal ray). Origin of adipose directly over or slightly posterior to end of anal base. Pectoral base midway between snout and a point somewhere between VO_5 and AOa_2; fin extending about to PO_4. Ventral base about twice as close to dorsal origin as to pectoral base; fin extending to a point somewhere between VO_4 and SAO_1. Scales cycloid, 37 (35-38) in lateral line.

Measurements in percent of standard length based on 50 specimens 15.5 to 34.7 mm. in standard length: length of head 31.2 (28.3-34.2); diameter of orbit 6.5 (4.9-8.8); length of maxillary 20.8 (18.2-24.0); distance from dorsal to ventral 17.4 (14.7-20.1); distance from dorsal to anal 19.2 (17.3-21.9); depth of

caudal peduncle 8.3 (6.6-9.7); distance from snout to dorsal 51.0 (48.4-56.1); length of dorsal base 16.2 (14.2-18.7); distance from snout to anal 59.1 (53.6-61.8); length of anal base 19.7 (17.4-21.4); distance from snout to adipose 77.5 (74.2-82.2); distance from snout to pectoral 30.9 (28.0-33.7); distance from snout to ventral 43.7 (41.3-46.8).

A well developed Vn and a small but well developed Ce (this organ frequently lost). Op_1 small, a little below and behind posterior end of maxillary; Op_2 about the same size as neighboring organs, somewhat below PVO_2 and a little behind Op_1. PLO well in advance of PVO_1, about its own diameter below lateral line. In specimens which have lost the anterior lateral line scales, the PLO, lying on the dividing septum between the epaxial and hypaxial muscles, appears to be on the lateral line which, however, does not follow the septum anteriorly but forms a shallow arch over the PLO. PVO_1 closer to PO_1 than to PO_2, about midway

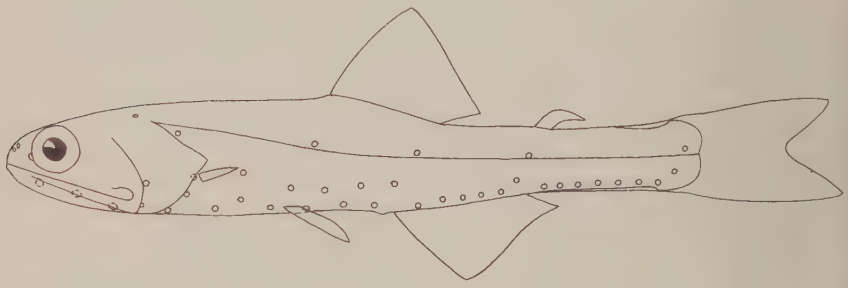

Fig. 21. *Lampanyctus mexicanus* (Gilbert).

between ventral body margin and PVO_2 and well in advance of this organ which is just in front of upper part of pectoral base, about on a line between Op_2 and PO_4. Five PO; first, second and fifth PO forming slightly diverging straight lines from ventral view; first interspace equal to or slightly smaller than that between PO_2 and PO_5; PO_1 on a vertical about midway between Op_2 and PVO_1; PO_5 just antero-mesad to base of outer ventral rays; PO_3 elevated so that it lies just above a line through top edge of PO_2 and PO_5, slightly closer to PO_2 than to PO_5; PO_4 elevated to about midway between PO_3 and lateral line, advanced to a position almost over PO_3. VLO somewhat behind VO_1, above lateral line but almost in contact with it. Five VO (6 on 1 side of 1 specimen); first, fourth, and fifth VO forming parallel straight lines from ventral view; interspace between VO_1 and VO_4 equal to or somewhat greater than last interspace; VO_1 just behind and very slightly laterad to base of inner ventral rays; VO_2 elevated and markedly advanced so that it lies far anterior to VO_1, over ventral base, somewhat above level of PVO_1; VO_3 elevated to same level, about midway between VO_1 and VO_4. SAO strongly angulated; SAO_1 about over middle of last VO interspace, a little above VO_3; SAO_2 directly over or slightly behind anal origin, about on same level as, or a little above SAO_1; SAO_3 directly over or somewhat behind AOa_1,

above lateral line but almost in contact with it. Five (4-6) + 5 (4-6) AO; AOa_1 usually very slightly depressed, followed by a somewhat enlarged interspace; AOp_1 well behind end of anal base, separated from last AOa by an interspace equal to from 0.5 to 0.7 depth of caudal peduncle. Two Pol forming an ascending straight line or slight arc with last AOa; Pol_1 usually markedly closer to last AOa than to Pol_2 which is above lateral line but in contact with it and directly over or somewhat behind base of last anal ray. Prc forming an ascending arc directly continuous with AOp series, but always counted as 4; Prc_1 and Prc_2 about on line with AOp series; Prc_3 elevated about half way to lateral line; Prc_4 about its own diameter above lateral line, well behind Prc_3. Three or 4 supracaudal luminous glands extending between verticals of last or next to last AOp and Prc_2 or Prc_3; 5 or 6 infracaudal glands extending from about AOp_1 to Prc_2.

Lateral and ventral surfaces of body pale metallic blue; dorsal region dark blue; entire body becoming blackish in alcohol. In life the caudal glands emit a brilliant dark blue light, each individual gland clearly visible.

I have examined 114 specimens of *Lampanyctus mexicanus*, 15.5 to 64.7 mm. in standard length, from the following localities: off Point Conception, California, Lat. 34° 05' N., Long. 121° 40' W., 2 specimens; off Santa Cruz Island, Lat. 33° 40' N., Long. 119° 32' W., 28 specimens; San Pedro Channel, Lat. 33° 33' N., Long. 118° 23' W., 36 specimens; Lat. 33° 28' 30" N., Long. 118° 21' 30" W., 18 specimens; Outer Santa Barbara Passage, Lat. 33° 27' 45" N., Long. 118° 57' 40" W., 1 specimen; Lat. 33° 11' N., Long. 118° 21' 30" W., 19 specimens; off San Clemente Island, Lat. 32° 52' 30" N., Long. 118° 54' W., 4 specimens; off La Jolla, 1 specimen; off Point Sal si puedes, Lower California, Lat. 32° 02' N., Long. 117° 01' W., 1 specimen; off Santo Tomas Point, Lat. 31° 33' N., Long. 117° 01' W., 1 specimen; off Cape Colnett, Lat. 30° 35' N., Long. 117° 52' W., 2 specimens; off Carmen Island, Gulf of California, Lat. 25° 59' 45" N., Long. 111° 03' 30" W., 2 specimens (cotypes); off Guaymas, Sonora, Lat. 27° 34' N., Long. 110° 53' 40" W., 3 specimens; about 50 miles south of Guaymas, 1 specimen. The 4 specimens from the last two stations listed are part of the material on which Garman based his *Myctophum oculeum*.

This species is known from numerous stations between Point Conception, California, Lat. 34° 05' N., Long. 121° 40' W., and the coast of Panama, Lat. 4° 56' N., Long. 80° 52' 30" W. It has not previously been reported from the coast of the United States.

Lampanyctus mexicanus appears to be a comparatively isolated form showing some degree of relationship to several different aggregates of species. It agrees well in the position of most of the photophores with *L. micropterus* Brauer and *L. nigrescens* Brauer and is also quite similar to the former species in general body form, but differs markedly in having a well developed Ce and an elevated VO_3. It agrees even better, as far as photophores are concerned, with *L. microchir* (Gilbert), which may have a Ce and which has the VO_2 in advance of the VO_1, but from this species it differs widely in certain proportions, particularly in the size of eye and depth of body. In general appearance, *L. mexicanus* is most similar to Tåning's three species, *L. ater*, *L. cuprarius* and *L. lineatus*, agreeing with them in the slender body form, the minute pectorals, the relative position of all fins and in most of the photophores. However, these forms do not have a Ce nor are any of the VO elevated. There is evidence of fairly close relationship to *L. omostigma* Gilbert, *L. parvicauda* Parr, *L. macropterus* Brauer and *L. nobilis* Tåning, all of which have a well developed Ce and a somewhat elevated VO_2, but these forms differ in having large pectorals, the VLO well below the lateral line and

the AO interspace definitely in front of the end of the anal base. *Lampanyctus idostigma* may be a somewhat closer relative since it has small pectorals, but in this form there is no marked elevation of any of the VO.

Lampanyctus idostigma Parr

Lampanyctus idostigma Parr, 1931, p. 33, fig. 13 (off the Pacific coast of southern Mexico, Lat. 16° 14' N., Long. 99° 36' 30" W.).

Body moderately slender; dorsal and ventral contours roughly parallel anterior to dorsal origin; body tapering evenly from anal origin to caudal peduncle. Upper anterior profile gently and evenly rounded or slightly flattened above eyes; snout bluntly pointed; mouth terminal. Maxillary slightly but very abruptly expanded posteriorly; extending far beyond eye, about 0.6 of its length lying behind a perpendicular to mouth drawn through posterior margin of orbit. A few small teeth on each side of vomer; palatine teeth in a narrow band. Eye rather small, about 1.2 times length of snout. Opercular margin ending in a blunt point.

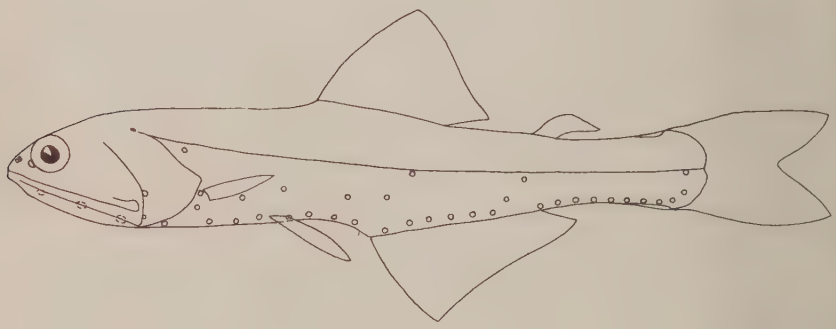

Fig. 22. *Lampanyctus idostigma* Parr.

Gill-rakers long, slender, those at angle equal to about 0.8 diameter of orbit; 4 + 1 + 10 or 11 on first arch with a rudimentary one on the anterior end of each limb.

Fin formula: D. 13-14; A. 18; P. 11-12; V. 8. Dorsal origin midway between snout and a point somewhere between AOp_4 and AOp_6; dorsal base 1.4 (1.3-1.5) in anal base. Anal origin about under middle of dorsal base (under seventh or eighth ray). Adipose directly over end of anal base. Pectoral base midway between snout and AOa_1 or AOa_2; fin extending about to VLO. Ventral base about twice as close to dorsal origin as to pectoral base; fin extending about to anal origin. Scales entirely lost in both available specimens; recorded by Parr as about 30-32 in lateral line.

Measurements in percent of standard length, based on 2 specimens 50.0 and

39.8 mm. in standard length: length of head 29.1 (29.0-29.2); diameter of orbit 5.4 (5.2-5.7); length of maxillary 20.9 (20.6-21.2); distance from dorsal to ventral 18.5 (17.4-19.6); distance from dorsal to anal 21.4 (21.0-21.9); depth of caudal peduncle 9.8 (9.7-9.8); distance from snout to dorsal 46.6 (46.1-47.2); length of dorsal base 19.1 (18.2-20.0); distance from snout to anal 54.2 (50.6-57.9); length of anal base 27.0 (26.2-27.8); distance from snout to adipose 78.5 (78.4-78.6); distance from snout to pectoral 29.2 (29.0-29.5); distance from snout to ventral 39.7 (38.0-41.4).

A well developed Vn, and a small but well developed Ce. Op_1 small, a little below and behind posterior end of maxillary; Op_2 about on level of PVO_2 and directly over or very slightly behind Op_1. PLO well in advance of PVO_2, about its own diameter below lateral line. PVO_1 a little in advance of PO_2, about midway between ventral body margin and PVO_2, which is just in advance of upper part of pectoral base and directly over or very slightly behind PVO_1. Five PO; PO_1 markedly nearer to Op_1 than to PVO_1; first PO interspace much greater than second which is equal to or slightly greater than that between PO_3 and PO_5; PO_4 elevated almost to level of PVO_2, advanced to a position almost over PO_3; from ventral view the first 3 pairs form parallel straight lines, fifth pair divergent, located directly anterior to base of outer ventral rays. VLO slightly anterior to VO_1, about midway between ventral base and lateral line. Four VO; VO_1 a little postero-mesad to base of inner ventral rays; VO_2 slightly divergent and forming converging straight lines with remaining organs; first VO interspace reduced, second equal to or somewhat greater than last. SAO strongly angulated; SAO_1 about over middle of last VO interspace, midway between ventral body margin and lateral line or slightly lower; SAO_2 on same level and about over AOa_1; SAO_3 about over or even slightly behind AO_2, in contact with lateral line. Five (5-6) + 6 (5-7) AO; AOa_1 slightly depressed, followed by a somewhat enlarged interspace; AOp_1 about over or a little anterior to base of last anal ray, separated from last AOa by an interspace equal to about 0.6 depth of caudal peduncle. Two Pol forming an ascending straight line with last AOa; Pol_1 somewhat closer to last AOa than to Pol_2 which is about its own diameter below lateral line and well in advance of AOp_1. Prc continuous with AOp, but always counted as 4; first 3 Prc about equidistant from each other and forming a gently ascending arc; Prc_4 separated by a wider interspace, about over Prc_3 and in contact with lateral line. Two or 3 supracaudal luminous glands extending between verticals of last AOp and Prc_2; 3 similar infracaudal glands extending from about the next to last AOp to the Prc_2.

Color in alcohol a rather pale and uniform yellowish brown.

I have been able to examine only two specimens of *Lampanyctus idostigma* both in rather poor condition. These specimens are part of Parr's original material and were taken off the Pacific coast of Nicaragua, Lat. 11° 05' N., Long. 89° 20' 45" W. The species is known from only three stations, the one noted above, the type locality off southern Mexico, and a station in the Gulf of California, Lat. 24° 07' N., Long. 108° 40' W.

Except for the possession of a Ce, this species differs in only minor details from *Lampanyctus niger* (Brauer) and *L. macdonaldi* (Goode and Bean). Among the species with a Ce, it appears to be most closely related to *L. nobilis* and *L. mexicanus*, differing from the former in having a short pectoral and from the latter in not having the VLO at the lateral line nor any of the VO photophores markedly elevated.

Lampanyctus steinbecki, new species

Body moderately slender, dorsal and ventral contours roughly parallel anteriorly, tapering abruptly under dorsal fin and gradually behind that point. Upper anterior profile gently curved, slightly concave above eyes; snout bluntly pointed; mouth terminal. Maxillary slightly but very abruptly expanded posteriorly; extending far beyond eye, about 0.6 of its length lying behind a perpendicular to mouth drawn through posterior margin of orbit. A few teeth on each side of vomer; palatine teeth in a narrow band. Eye rather small, orbital diameter about 1.2 times length of snout. Opercular margin ending in a blunt point. Gill-rakers long, slender, those at angle equal to about 0.8 diameter of orbit; 4 + 1 + 8 on first arch with a rudimentary one at anterior end of lower limb.

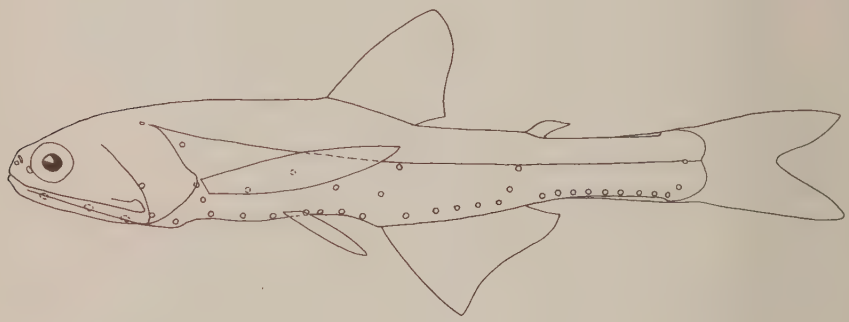

Fig. 23. *Lampanyctus steinbecki*, new species.

Fin formula: D. 12; A. 16; P. 12; V. 8. Dorsal origin midway between snout and next to last AOp; dorsal base 1.6 in anal base. Anal origin slightly in advance of end of dorsal base (under tenth or eleventh ray). Origin of adipose fin directly over end of anal base. Pectoral base midway between snout and AOa_1; fin extending almost to AOa_2. Ventral base about 3 times as close to dorsal origin as to pectoral base; fin extending to anal origin. Scales cycloid, about 36 in lateral line.

Measurements of type in mm. and percent of standard length (figures in parentheses are percent of standard length): length of head 10.5 (29.6); diameter of orbit 2.3 (6.5); length of maxillary 7.9 (22.2); distance from dorsal to ventral 6.5 (18.3); distance from dorsal to anal 7.5 (21.1); depth of caudal peduncle 3.2 (9.0); distance from snout to dorsal 17.2 (48.4); length of dorsal base 4.9 (13.8); distance from snout to anal 20.1 (56.6); length of anal base 7.7 (21.7); distance from snout to adipose 27.0 (76.1); distance from snout to pectoral 10.5 (29.6); distance from snout to ventral 14.7 (41.4).

A well developed Vn and a small Ce. Op_1 large, about equal to size of neighboring organs, a little below and behind posterior end of maxillary; Op_2

about on same level as PVO_2 and well in advance of Op_1. PLO somewhat in advance of PVO_2 about twice its own diameter below lateral line. PVO_1 markedly behind PVO_2, midway between PO_2 and PVO_2 and on a straight line connecting these 2 organs; PVO_2 in advance of upper part of pectoral base. Five PO; PO_1 on a vertical somewhat nearer to Op_1 than to PVO_2; first PO interspace slightly greater than second which is about equal to that between PO_3 and PO_5. PO_4 elevated almost to level of PVO_2, advanced to a position almost over PO_3; from ventral view the 4 lower pairs of organs form slightly curved lines with the convexity directed inward; PO_5 directly anterior to base of outer ventral rays. VLO about over middle of ventral base, twice as close to lateral line as to ventral base. Four VO, none elevated, forming parallel straight lines from ventral view; VO_1 immediately behind base of inner ventral rays; first interspace slightly shorter than the others. SAO strongly angulated; SAO_1 slightly in advance of VO_3, about midway between ventral body margin and lateral line; SAO_2 a little lower, about over anal origin; SAO_3 very slightly in advance of AOa_1, in contact with lateral line. AO 5 + 7; AOa_1 followed by a somewhat enlarged interspace, very slightly depressed; AOp_1 well behind end of anal base, separated from last AOa by an interspace equal to about 0.7 depth of caudal peduncle. Two Pol forming an ascending arc with last AOa; Pol_1 somewhat closer to last AOa than to Pol_2 which is slightly in advance of end of anal base and in contact with lateral line. Four Prc, the first 3 evenly spaced and forming a slightly ascending arc directly continuous with AOp series; Prc_4 slightly behind Prc_3, separated from it by a much enlarged interspace, in contact with lateral line. Four supracaudal luminous glands extending from just in front of AOp_5 to Prc_1; 6 similar infracaudal glands extending from the second AOp interspace to Prc_2.

Color in alcohol a rather uniform pale brown.

The holotype and only known specimen (Stanford Natural History Museum No. 33658) is 35.5 mm. in standard length. It was collected September 18, 1918, off Lone Point, Santa Catalina Island, at a depth of 800 feet. The name of the collector is not legible on the label, but the specimen was presented to me by the California Division of Fish and Game.

This species appears to be most closely related to *Lampanyctus nobilis* but differs in having fewer fin rays, the PVO_1 more posterior in position, none of the VO markedly elevated, the SAO_1 higher and more advanced, the AO interspace over instead of in front of the end of the anal base, and no distinct separation between the AO and Prc series. *L. festivus* Tåning must also be considered as a close relative in case it is found to have a Ce. Although Tåning's lamentably brief diagnosis is entirely inadequate for any satisfactory comparison of the two species, *L. steinbecki* seems to differ from this Atlantic form in having fewer anal rays, fewer AOa, and a shorter series of infracaudal luminous glands.

Named for my friend, Mr. John Steinbeck.

Lampanyctus ritteri Gilbert

Lampanyctus ritteri Gilbert, 1915, p. 318, pl. 15, fig. 3 (Albatross station 4513, Monterey Bay, California).

Body moderately robust; dorsal and ventral contours about parallel anterior to dorsal origin, narrowing rather abruptly under dorsal base and then tapering evenly to rather heavy caudal peduncle. Upper anterior profile gently and

evenly rounded or flattened above orbits; snout bluntly pointed; mouth terminal. Maxillary slightly but abruptly expanded posteriorly; extending far beyond eye, about 0.5 or 0.6 of its length lying behind a perpendicular to the mouth drawn through posterior margin of orbit. A small patch of teeth on each side of vomer; palatine teeth in a narrow band. Eye rather small, orbital diameter about equal to length of snout. Opercular margin ending in a moderately sharp point. Gill-rakers long, slender, those at angle equal to about 0.8 diameter of pupil; 4 + 1 + 9 on first arch (6 specimens counted).

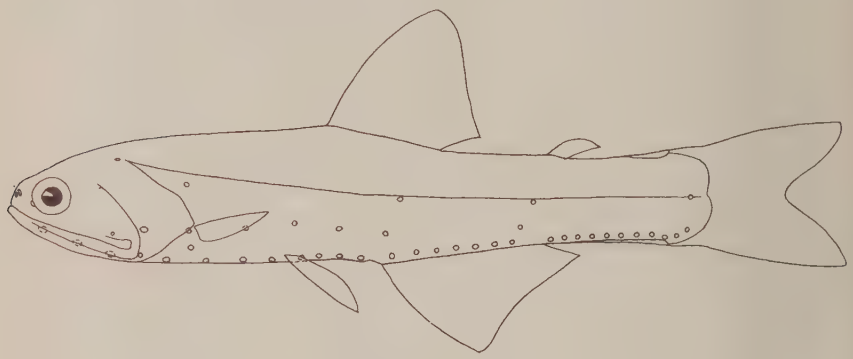

Fig. 24. *Lampanyctus ritteri* Gilbert.

Fin formula: D. 13 (13-15); A. 18 (17-19); P. 11 (11-12); V. 8. Dorsal origin midway between snout and a point somewhere between next to last AOp and Prc_1; dorsal base 1.4 (1.1-1.5) in anal base. Anal origin about under middle of dorsal base (under seventh to ninth ray). Origin of adipose directly over or slightly behind end of anal base. Pectoral base midway between snout and a point somewhere between anal origin and AOa_3; fin extending about to ventral base. Ventral base about twice as close to dorsal origin as to pectoral base; fin extending almost or quite to anal origin. Scales cycloid, 37 or 38 in lateral line.

Measurements in percent of standard length based on 22 specimens 21.0 to 100.0 mm. in standard length: length of head 29.4 (27.2-32.2); diameter of orbit 6.5 (5.6-7.1); length of maxillary 21.2 (19.4-22.9); distance from dorsal to ventral 18.5 (17.1-21.2); distance from dorsal to anal 20.3 (18.1-22.3); depth of caudal peduncle 10.0 (7.6-12.9); distance from snout to dorsal 49.6 (47.1-53.3); length of dorsal base 16.5 (14.7-20.2); distance from snout to anal 56.5 (53.4-62.4); length of anal base 22.8 (21.4-24.7); distance from snout to adipose 78.6 (76.0-82.8); distance from snout to pectoral 31.0 (28.4-33.5); distance from snout to ventral 42.8 (39.4-45.9).

In well preserved specimens, the more ventral photophores, particularly the PO, VO and AO series, are divided by slightly curved, horizontal, black septa, as well defined as those found in *Diaphus*. A well developed Vn, a small

Ce, and a small Bu located just above edge of maxillary on vertical of Br_3. Op_1 small, a little below and behind posterior end of maxillary; Op_2 on level of PVO_2 and very slightly behind Op_1. PLO over PVO_2 and about 2 times its own diameter below lateral line. PVO_1 a little in advance of PO_2, about midway between ventral body margin and PVO_2 which is just in advance of upper part of pectoral base and usually over or slightly in advance of, rarely slightly behind PVO_1. Five PO; PO_1 about midway between Op_1 and PVO_1, first PO interspace somewhat greater than or rarely equal to second which is equal to or slightly greater than that between PO_3 and PO_5; PO_4 elevated so that it forms a straight line with Op_2 and PVO_2, advanced to a position almost over PO_3; from ventral view all organs, with exception of fourth, form slightly diverging straight lines; PO_5 a little antero-mesad to base of outer ventral rays. VLO about over middle of ventral base, midway between ventral base and lateral line or slightly lower, forming a straight line with SAO_1 and SAO_2. Four VO; VO_1 just posterior to base of inner ventral rays; VO_2 slightly divergent and forming converging straight lines with remaining organs; all VO interspaces about equal. SAO strongly angulated; SAO_1 about over VO_3, slightly lower than VLO; SAO_2 about over anal origin, slightly below SAO_1; SAO_3 over first AOa interspace, in contact with lateral line. Seven (6-8) + 8 (8-9) AO; AOa_1 usually slightly depressed, often followed by a somewhat enlarged interspace; AOp_1 over or slightly behind base of last anal ray, separated from last AOa by an interspace equal to from 0.3 to 0.5 depth of caudal peduncle. Two Pol forming an ascending straight line with last AOa; Pol_1 markedly closer to last AOa than to Pol_2 which is in contact with lateral line. Prc continuous with AOp, but always counted as 4; first 3 Prc about equidistant from each other and forming a very gently ascending arc; Prc_4 separated by a much wider interspace, almost directly over Prc_3, in contact with lateral line. Two or 3 supracaudal luminous glands extending from about next to last AOp to Prc_1 or Prc_2; 6 (5-7) infracaudal glands extending between AOp_2 or AOp_3 and Prc_1.

General body color very dark brownish black with pale blue metallic reflections from such scales as remain; fins dusky, particularly near bases.

I have examined 24 specimens of *Lampanyctus ritteri*, 19.9 to 100.0 mm. in standard length, from the following localities: off Point Reyes, California, Lat. 37° 50' N., Long. 123° 25' W., 1 specimen; off Monterey Bay, Lat. 36° 44' N., Long. 122° 01' W., 1 specimen; off Carmel, Lat. 36° 35' N., Long. 122° 11' W., 1 specimen; off southern California, Lat. 33° 42' N., Long. 121° 24' W., 1 specimen; off Santa Rosa Island, Lat. 33° 42' N., Long. 120° 22' W., 1 specimen; off Santa Cruz Island, Lat. 33° 40' N., Long. 119° 32' W., 4 specimens; San Pedro Channel, Lat. 33° 42' N., Long. 118° 25' W., 2 specimens; Lat. 33° 28' 30" N., Long. 118° 21' 30" W., 5 specimens; Lat. 33° 33' N., Long. 118° 23' W., 2 specimens; 5.4 miles off east end of San Clemente Island, 1 specimen (cotype); Outer Santa Barbara Passage, Lat. 33° 27' 45" N., Long. 118° 57' 40" W., 3 specimens; Lat. 32° 50' 20" N., Long. 118° 03' 30" W., 1 specimen (cotype); off La Jolla, 1 specimen.

This species has previously been known from only the type material, taken in Monterey Bay and in the vicinity of San Clemente Island. Its known range is here extended about 100 miles northward, to Point Reyes.

Lampanyctus ritteri appears to be most closely related to *L. regalis*, from which it is very easily distinguished by the much lower position of the VLO. Additional differences are found in the larger size of the photophores, in the more posterior position of the SAO, and in the more anterior insertion of the ventral fins.

Lampanyctus regalis (Gilbert)

Myctophum regale Gilbert, 1891, p. 544 (Albatross station 2923, off San Diego, California).
Nannobrachium regale Goode and Bean, 1895, p. 512.
Myctophum (Lampanyctus) regale Brauer, 1904, p. 396.
Lampanyctus regalis Gilbert, 1915, p. 316; Parr, 1929a, p. 24, fig. 11.
Lampanyctus regale Gilbert, 1915, p. 320.

Body moderately robust; dorsal and ventral contours roughly parallel anterior to dorsal origin, narrowing rather abruptly under dorsal base, and then tapering evenly to heavy caudal peduncle. Upper anterior profile evenly rounded or somewhat flattened, sometimes even slightly concave above eyes; snout pointed; mouth terminal. Maxillary slightly but abruptly expanded at its posterior end; extending far beyond eye, about 0.5 or 0.6 of its length lying behind a perpendicular to mouth drawn through posterior margin of orbit. A small oval patch of teeth on each side of vomer; palatine teeth in a narrow band. Eye small, orbital diameter about equal to snout in large specimens, shorter than snout in small individuals. Opercular margin ending in a blunt point. Gill-rakers long, slender, those at angle equal to 0.8 or 0.9 diameter of orbit; 4 + 1 + 9 (8-9) on first arch with 1 or 2 rudimentary ones on the anterior end of each limb (4 specimens counted).

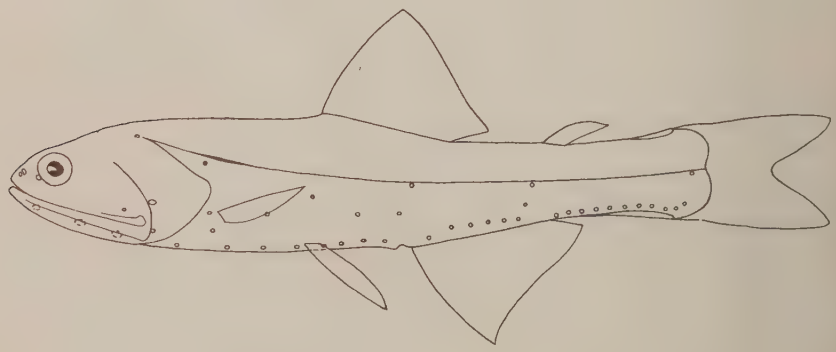

Fig. 25. *Lampanyctus regalis* (Gilbert).

Fin formula: D. 15 (14-16); A. 17 (17-18); P. 13 (12-14); V. 8. Dorsal origin midway between snout and a point somewhere between next to last AOp interspace and Prc_1; dorsal base 1.2 (1.0-1.4) in anal base. Anal origin well in advance of end of dorsal base (under tenth to twelfth dorsal ray). Adipose fin directly over end of anal base. Pectoral base midway between snout and a point

somewhere between AOa_1 and AOa_4; fin extending to or slightly beyond ventral base. Ventral base only slightly anterior to dorsal origin; fin extending to or a little beyond anal origin. Scales cycloid, about 37 in lateral line.

Measurements in percent of standard length based on 7 specimens 17.7 to 165.5 mm. in standard length: length of head 30.7 (28.6-33.5); diameter of orbit 6.1 (4.9-7.9); length of maxillary 21.4 (19.2-23.7); distance from dorsal to ventral 19.6 (17.7-20.9); distance from dorsal to anal 22.8 (21.8-24.3); depth of caudal peduncle 9.7 (8.6-10.8); distance from snout to dorsal 49.0 (44.8-50.8); length of dorsal base 18.3 (17.0-20.5); distance from snout to anal 59.2 (57.3-61.2); length of anal base 21.7 (19.8-23.7); distance from snout to adipose 79.0 (76.8-80.9); distance from snout to pectoral 32.0 (29.6-34.7); distance from snout to ventral 45.1 (42.2-47.4).

All of the photophores very small. A well developed Vn and a small Ce. A small and rather poorly defined Bu just above edge of maxillary on vertical of Br_3. The extremely minute luminous organs which, according to Gilbert (1915), appear to be distributed over almost the entire head, are not well defined. They appear like small mucus pores and are not distinguishable in small specimens. Op_1 a little below and behind end of maxillary, about the same size as neighboring organs; Op_2 considerably larger, somewhat above PVO_2 and directly over or slightly behind Op_1. PLO slightly in advance of PVO_2, about twice its own diameter below lateral line. PVO_1 a little in front of PO_2, about midway between ventral body margin and PVO_2 which is just in front of upper ventral rays and very little in advance of PVO_1. Five PO; PO_1 somewhat nearer Op_1 than PVO_1; first PO interspace a little greater than second which is about equal to that between PO_3 and PO_5; PO_4 elevated so that it forms an approximately straight line with Op_2 and PVO_2, advanced to a position almost over PO_3; from ventral view the first 3 pairs of organs form gently diverging straight lines; PO_5 more abruptly divergent, located a little antero-mesad to base of outer ventral rays. VLO about over middle of ventral base, about twice as close to lateral line as to ventral base. Four VO; VO_1 just posterior to base of inner ventral rays; VO_2 slightly divergent and forming converging straight lines with remaining organs; first VO interspace very slightly reduced, last 2 about equal to each other. SAO strongly angulated; SAO_1 anterior to VO_3, about midway between ventral body margin and lateral line; SAO_2 slightly behind anus, on about same level as SAO_1 and forming a straight line with this organ and PO_4; SAO_3 about over anal origin and in contact with lateral line. Six (6-7) + 8 (7-8) AO; AOa_1 markedly depressed, followed by an enlarged interspace; AOp_1 slightly behind base of last anal ray, separated from last AOa by an interspace equal to about 0.5 or 0.6 depth of caudal peduncle. Two Pol forming an ascending straight line or slight arc with last AOa; Pol_1 slightly closer to last AOa than to Pol_2 which is in contact with lateral line. Four Prc, directly continuous with AOp series, or separated from it by a slightly enlarged interspace; first 3 Prc equally spaced and forming a gently ascending arc; Prc_4 separated by a much wider interspace, well behind Prc_3 and in contact with lateral line. Three supracaudal luminous glands extending between verticals of next to last AOp interspace and Prc_2 or Prc_3; 6 or 7 infracaudal luminous glands extending from about AOp_3 to Prc_2.

General body color black; fins dusky.

Included in my material are a few post-larval individuals, the youngest 17.7 mm. in standard length (fig. 26). At this stage the anterior part of the body is heavier than in the adult, the snout is comparatively long, the mouth is short, and the maxillary does not extend far beyond the eye. No trace of the

larval fin fold remains and the rays are well developed in all of the fins. The photophores are just beginning to form and the PO_1, PO_5 and PVO_1 can readily be distinguished. The supra- and infracaudal luminous glands are already present. The head and posterior half of the body are practically colorless, while a broad dark band encircles the body just behind the head. This is partially due to the dark peritoneum showing through the slightly translucent body wall, but mainly to prominent melanophores in the myosepta that expand to some extent on the surface. A prominent melanophore occurs on the ventral fin near its base.

Fig. 26. *Lampanyctus regalis* (Gilbert). Early post-larval stage, 17.7 mm. in standard length.

In a somewhat older specimen, 20.6 mm. in standard length, the Op photophores and all of the PO and VO are well formed, while the AO series is poorly developed. Dark pigmentation is developing over the entire body and obscuring, to some extent, the dark lines of melanophores in the myosepta.

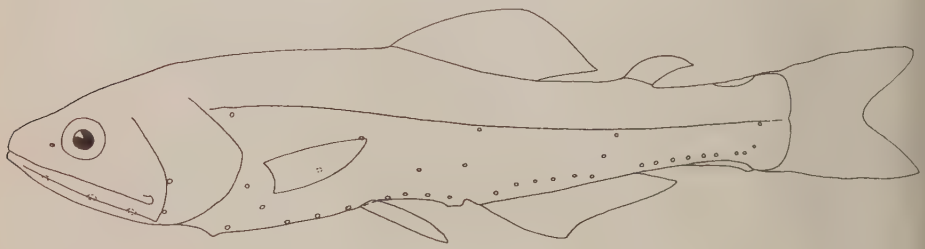

Fig. 27. *Lampanyctus regalis* (Gilbert). Late post-larval stage, 25.1 mm. in standard length.

In a still older specimen, 25.1 mm. in standard length (fig. 27), the anterior part of the body remains heavy and the snout long. The maxillary extends farther behind the eye, and all of the photophores, with the exception of the Bu and Ce, are well enough developed to enable their determination, although the more dorsal and posterior organs are not well defined. Scale pockets are promi-

nent and the color is so dark that the myoseptal streaks of the younger stages are almost invisible.

In a 27.8 mm. specimen the body is thinner anteriorly, the length of the snout is somewhat reduced, the maxillary has reached its adult proportions and all of the luminous organs are fully developed.

I have examined 7 specimens of this species from the following localities: off Carmel, California, Lat. 36° 35' N., Long. 122° 11' W., 2 specimens; Santa Barbara Channel, Lat. 34° 14' 45" N., Long. 119° 54' 00" W., 1 specimen; off Santa Cruz Island, Lat. 33° 49' 45" N., Long. 119° 24' 30" W., 1 specimen; San Pedro Channel, Lat. 33° 33' N., Long. 118° 23' W., 1 specimen; Outer Santa Barbara Passage, 1 specimen (cotype); off San Clemente Island, Lat. 32° 52' 30" N., Long. 118° 54' W., 1 specimen.

This species has hitherto been taken only from the region of the Santa Barbara Islands. Its known range is here extended northward about 200 miles.

Lampanyctus townsendi (Eigenmann and Eigenmann)

Myctophum townsendi Eigenmann and Eigenmann, 1889, p. 125 (off San Diego).
Scopelus (Nyctophus) warmingii Lütken, 1892, p. 259, fig. 19 (open Atlantic, Lat. 32° 06' N., Long. 39° 28' W.).
Scopelus townsendi Lütken, 1892, p. 267.
Lampanyctus warmingii Goode and Bean, 1895, p. 80.
Lampanyctus townsendi Jordan and Evermann, 1896, p. 558; Gilbert 1908, p. 230, pl. 4; Norman, 1930, p. 327; Matsubara, 1938, p. 56, fig. 11.
Myctophum (Lampanyctus) warmingi Brauer, 1906, p. 229.
Myctophum (Lampanyctus) townsendi Brauer, 1906, p. 167.

Body moderately robust; dorsal and ventral contours roughly parallel anterior to dorsal origin, dorsal contour descending more abruptly under dorsal base, body tapering evenly from anal origin to caudal peduncle. Upper anterior profile gently curved, flattened above eyes; snout sharply rounded, steep, blunt; mouth terminal. Maxillary of almost uniform width behind eye, without any marked posterior expansion; extending well beyond eye, about 0.3 of its length lying behind a perpendicular to mouth drawn through posterior margin of orbit. A single small fang-like tooth on each side of vomer; palatine teeth in a single series. Eye large, orbital diameter 1.4 to 1.8 times length of snout. Opercular margin ending in a bluntly rounded lobe. Gill-rakers moderately long and slender, those at angle equal to about 0.6 diameter of orbit; 4 + 1 + 10 (9-10) with from 2 to 4 small rudimentary ones on the anterior part of each limb (5 specimens counted).

Fin formula: D. 14 (13-14); A. 14; P. 13 (13-14); V. 8. Dorsal origin midway between snout and a point somewhere between next to last AOp and Prc_1; dorsal base 1.0 (0.9-1.1) in anal base. Anal origin directly under or slightly posterior to end of dorsal base. Adipose fin directly over or very slightly behind end of anal base. Pectoral base midway between snout and a point somewhere between AOa_2 and AOa_5; fin extending about to or a little beyond anal origin. Ventral base about under dorsal origin; fin extending about to anal origin. Scales cycloid; about 37 in lateral line.

Measurements in percent of standard length based on 6 specimens 17.4 to 57.1 mm. in standard length: length of head 34.4 (33.2-36.1); diameter of orbit 9.7 (8.6-11.3); length of maxillary 23.6 (22.2-25.3); distance from dorsal to

ventral 19.6 (18.4-20.6); distance from dorsal to anal 26.4 (24.2-28.7); depth of caudal peduncle 10.4 (9.6-12.0); distance from snout to dorsal 47.5 (46.8-48.2); length of dorsal base 16.3 (14.9-17.6); distance from snout to anal 64.0 (60.2-66.7); length of anal base 16.0 (13.8-18.3); distance from snout to adipose 78.1 (75.3-80.8); distance from snout to pectoral 36.3 (35.5-37.0); distance from snout to ventral 48.2 (45.7-51.2).

A well developed Vn. Op_1 a little below and behind end of maxillary; Op_2 somewhat below PVO_2, slightly behind Op_1. PLO directly over PVO_1, about its own diameter below lateral line in California specimens, in contact with lateral line in material from Japan. PVO_1 very slightly in advance of PO_2, about midway be-

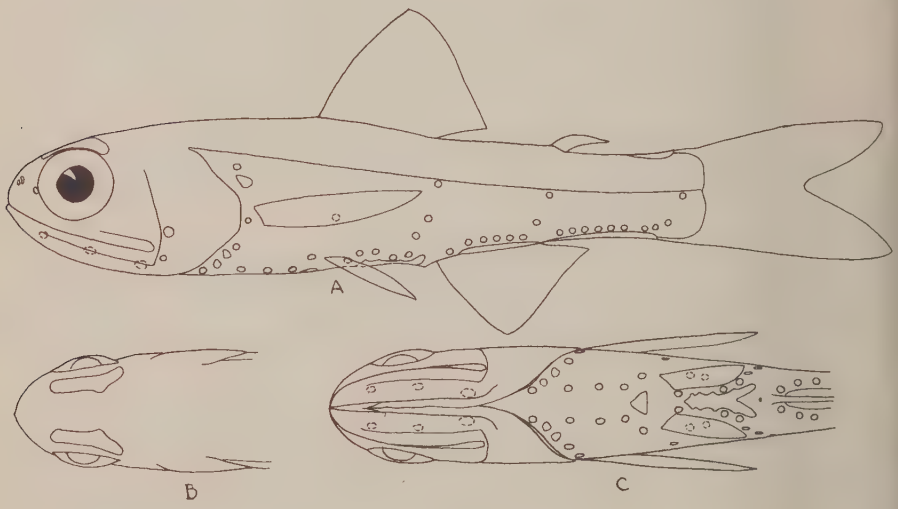

Fig. 28. *Lampanyctus townsendi* (Eigenmann and Eigenmann). A. Lateral view. B. Dorsal surface of head. C. Ventral view of anterior part of body.

tween ventral body margin and PVO_2 which is located a little anterior to base of middle ventral rays and well behind PVO_1. Five PO, the fourth not elevated; first interspace largest, last smallest, second and third about equal to each other or second slightly the larger; PO_1 midway between Op_1 and PVO_1 or slightly anterior to this point; from ventral view the first 4 pairs of organs forming straight or slightly curved lines, the convexity directed outward; PO_5 markedly divergent, located directly anterior to base of outer ventral ray. VLO about over middle of ventral base, midway between ventral base and lateral line. Five VO; VO_1 just postero-mesad to base of inner ventral rays; VO_4 about on same level or this pair slightly more widely spaced; VO_2, VO_3 and VO_5 somewhat elevated, forming slightly converging straight lines from ventral view. SAO slightly angulate; SAO_1 over and a little behind VO_5, about midway between VO_5 and SAO_2 but very slightly in ad-

vance of a line connecting these 2 organs; SAO_2 slightly in advance of anal origin somewhat closer to SAO_1 than to SAO_3 which is about over anal origin and in contact with lateral line. Six (5-6) + 6 (5-6) AO; AOa_1 slightly depressed, usually followed by an enlarged interspace; AOp_1 well behind end of anal base, separated from last AOa by an interspace equal to from 0.3 to 0.5 depth of caudal peduncle. Two Pol forming an ascending straight or slightly curved line with last AOa; Pol_1 somewhat closer to last AOa than to Pol_2 which is in contact with lateral line. Four Prc, separated from last AOp by an interspace equal to from 0.5 to 0.8 length of that between last AOa and AOp_1; first 3 Prc equally spaced or with first interspace slightly the shorter, forming a gently ascending arc; Prc_4 widely separated from and well behind Prc_3, in contact with lateral line. Luminous glands quite variable, or at least some or even all of them impossible to distinguish in old, museum-worn or improperly preserved specimens. A long, rather broad, and very clearly defined luminous gland extending along the entire dorsal rim of the orbit (decernable in only one recently captured specimen); a well developed gland a little below the PLO; 2 or 3 distinctly separate small glands in the triangular area formed by the PO_1, PO_2 and PVO_1 (Norman, 1930, reports 2 to 7 glands in this region); a small triangular gland, with the apex directed forward, on midventral line between the PO_5 pair; a midventral series of 4 glands, sometimes indistinctly separated, extending from VO_1 to anus, with an additional gland extending posteriorly on each side between anus and VO_5 giving the entire series an elongated Y-shape. A series of 6 or 7 glands, sometimes indistinctly separated, extending from AOa_1 or the first AOa interspace to somewhere between last AOa and end of anal base; infracaudal series similar, composed of 9-11 glands extending from immediately behind end of anal base to or slightly beyond Prc_2; 3-5 indistinctly separated supracaudal glands extending from about vertical of last AOp to Prc_3. No dorsal luminous areas between the supra-orbital and supracaudal glands.

General body color black, with metallic bluish reflections from opercles and scales; median fins slightly dusky; pectorals and ventrals almost colorless.

I have examined 7 specimens of this species from the following localities: off Point Buchon, California, Lat. 35° 05' N., Long. 123° 29' W., 1 specimen; off Point Conception, Lat. 34° 05' N., Long. 121° 40' W., 1 specimen; San Pedro Channel, Lat. 33° 28' 30" N., Long. 118° 21' 30" W., 1 specimen; Cortez Banks, 1 specimen; off southern Shikoku, Japan, Lat. 32° 05' N., Long. 133° 02' E., 2 specimens.

This species appears to be widely distributed in the tropical and temperate waters of the Atlantic, Pacific and Indian Oceans.

Lampanyctus townsendi differs markedly from the other species of *Lampanyctus* already discussed. The maxillary does not have an abrupt expansion at its posterior end, but widens very slightly and evenly behind the eye; the vomer has a single prominent tooth at each side instead of a small patch; the palatine dentition consists of a single series instead of a narrow band; the ventral base is under instead of well in advance of the dorsal origin; the anal origin is about under instead of well in advance of the end of the dorsal base; the PO_4 is not at all elevated, and luminous glands, other than the definite photophores, occur on the anterior part of the body.

Lampanyctus townsendi appears to be most closely related to *L. polyphotis* Beebe, and *L. maderensis* Lowe, differing from both in having no luminous glands along the mid-dorsal line anterior to the adipose fin. The characters listed above might seem sufficient to justify the placing of these three species in a

separate genus but several forms (*L. guntheri* Goode and Bean, *L. gaussi* Brauer, *L. subpectoralis* Parr) appear to be intermediate between this complex and the other species discussed, leaving no well defined evolutionary gap to justify the splitting.

Genus *NOTOSCOPELUS* Günther

Notoscopelus Günther, 1864, p. 405 (as a subgenus; genotype by subsequent designation of Goode and Bean, 1895, *Lampanyctus resplendens* Richardson = *Scopelus elongatus* Costa).

Catablemella Eigenmann and Eigenmann, 1890, p. 24 (genotype by original designation *Notoscopelus brachychir* Eigenmann and Eigenmann = *Scopelus elongatus* Costa).

Macrostoma Jordan and Evermann, 1896, p. 554 (see page 128, above).

Mouth large, extending far beyond orbit; narrow bands of cardiform teeth on premaxillaries and dentaries; a small patch of teeth on each side of vomer, its median line naked; a long narrow band of similar teeth on palatines and a large oval patch on entopterygoids. Gill-rakers well developed. Lateral line present, complete. Dorsal fin markedly longer than anal; anal origin well in advance of end of dorsal base; adipose fin behind end of anal base; pectorals short, never extending to anal origin; ventral base about under dorsal origin. No Bu nor Ce photophores; PVO_2 well above pectoral base; PO in line, none markedly elevated; SAO weakly angulated (1 or 2 of the SAO may be absent in some species); AO in 2 groups separated by an interspace which occurs over end of anal base; 1 to 3 Pol, arranged in a horizontal series if more than 1 is present; 3 or 4 Prc, clearly distinct from AO series; the first 2 low, close together, separated by an enlarged interspace from the last 1 or 2 organs which are close to lateral line.

The five species *Notoscopelus caudispinosus* (Johnson), *N. hoffmanni* (Fowler), *N. elongatus* (Costa), *N. margaritifer* Goode and Bean, and *N. castaneus* Goode and Bean, may be assigned to this genus. Most of these species are very poorly known, the names being based on the inadequate descriptions of the last century. New individuals of most of them are conspicuously absent from the collections of recent expeditions and the types have disintegrated in museums until many of the alleged differentiating characters are now illegible. Under these circumstances, it is futile to attempt to discuss the interrelationships of these forms. However, it may be noted that *N. hoffmanni* appears to be clearly distinct from *N. elongatus*, the only species recorded from the region treated in this work. It has the ventral and anal fins more advanced in relation to the dorsal, a Vn is present instead of a Dn, the PVO_2 is very low, the first PO interspace is not enlarged, and the SAO and Pol photophores are more posterior in position.

In modern keys *N. resplendens* (Richardson) has been revived and is differentiated from *N. elongatus* mainly by the fact that the origin of the anal is distinctly nearer to base of caudal than to posterior margin of orbit, instead of midway between these two points. However, examination of figures that are universally accepted as representations of *N. elongatus* reveals that in every case the anal origin is considerably nearer to the caudal base than to the orbit. Tåning (1928) also claims that the adult male of *N. elongatus* has a large luminous area on the cheek and that there is no supracaudal luminous plate. His own

iscussion of this species (1918) states, however, that there are 6-7 supracaudal luminous glands and mentions no luminous area on the cheek. The same author 1928) indicates that there is a difference between the angle formed by the SAO eries in the two species, although his figure of *N. elongatus* (1918) agrees in his respect with Richardson's original figure of *N. resplendens*. In short, åning's figure and description of 1918 agree (in his key of 1928) with *N. elongatus* in regard to the arrangement of the SAO series and in the number of AO; hey agree with *N. resplendens* in regard to the position of the anal origin, the resence of supracaudal glands and the lack of a large luminous area on the heek. It is certain that Tåning has erred somewhere, and it seems probable that hese two names are synonyms applied to a single rather variable species. It hould be added that Richardson's figure of *N. resplendens*, which certainly looks ifferent from *N. elongatus*, has apparently suffered from artistic license in the lacement of certain photophores and in certain body proportions, as well as in he very evident addition of several luminous organs.

Lampanyctus procerum (Brauer) which agrees with the genus *Notoscopelus* in aving a very high PVO_2 and two of its three Pol in a horizontal series, differs n so many characters (the short dorsal fin, the adipose in advance of end of nal base, the possession of three Bu, the advanced position of the AO interpace, the occurrence of the Prc in a 3 + 1 series) that it can not be placed in his group. It undoubtedly represents the closest relative of the genus and probbly will require the establishment of a monotypic genus for its reception.

Notoscopelus elongatus (Costa)

copelus elongatus Costa, 1844, p. 2 (Naples; *fide* Jordan and Evermann, 1896).
ampanyctus resplendens Richardson, 1844, p. 42, pl. 27, figs. 16-18 (Gulf of Guinea); Matsubara, 1938, p. 53, fig. 10.
copelus crocodilus Cuvier and Valenciennes, 1849, p. 332.
copelus kroyeri Malm, 1863, p. 100 (*fide* Brauer, 1906; Parr, 1928).
otoscopellus brachychier (err. typ.) Eigenmann and Eigenmann, 1889, p. 126 (Cortez Banks, off San Diego).
otoscopelus brachychir Eigenmann and Eigenmann, 1890, p. 23.
copelus pseudocrocodilus Moreau, 1891, p. 84, fig. 227 (*fide* Brauer, 1906).
yctophum elongatum Smitt, 1895, p. 937, fig. 234.
otoscopelus resplendens Goode and Bean, 1895, p. 83, fig. 94.
otoscopelus elongatus Goode and Bean, 1895, p. 83.
otoscopelus quercinus Goode and Bean, 1895, p. 83, fig. 97. (Albatross stations 2528 and 2731, off Cape Cod, Massachusetts and Cape Henry, Virginia).
acrostoma quercinum Jordan and Evermann, 1896, p. 554.
acrostoma angustidens Jordan and Evermann, 1896, p. 555.
acrostoma brachychir Jordan and Evermann, 1898, p. 2826.
otoscopelus ejectus Waite, 1904, p. 150, pl. 18, fig. 2 (Lord Howe Island).
yctophum (Lampanyctus) elongatum Brauer, 1906, p. 232, figs. 152-153.
yctophum (Lampanyctus) quercinum Brauer, 1906, p. 166.
acrostoma quercinum japonicum Tanaka, 1908, p. 5, pl. 1, fig. 3. (off Misaki, Sagami).
acrostoma japonicum Tanaka, 1911, p. 59, pl. 15, fig. 51.
ampanyctus japonicus Gilbert, 1913, p. 99.
ampanyctus elongatus Gilbert, 1913, p. 99.

Body slender, elongate; dorsal and ventral contours roughly parallel anterior to dorsal origin, tapering evenly from this point to caudal peduncle. Upper anterior profile gently and evenly rounded; snout steep, bluntly pointed; mouth terminal. Maxillary moderately widened posteriorly, a ventral expansion extending mesad to and slightly below end of premaxillary, its hind edge strongly oblique; extending far beyond eye, about 0.6 of its length lying behind a perpendicular to mouth drawn through posterior margin of orbit. Eye small, orbital diameter about 1.3 times length of snout. Opercular margin ending in a rather sharp point. Gill-rakers long, slender, those at angle equal to 0.8 or 0.9 diameter of orbit; 7 (7-8) + 1 + 16 (14-17) on first arch (both sides of 2 specimens counted).

Fin formula: D. 21; A. 19; P. 11 (11-12); V. 8. Dorsal origin midway between snout and AO interspace; dorsal base about 0.8 in anal base. Anal origin slightly behind middle of dorsal base (about under thirteenth ray). Adipose fin small, well behind end of anal base. Pectoral base midway between snout and SAO_1 or SAO_2; fin extending almost to last PO. Ventral base about under dorsal origin; fin extending about to anus. Scales ctenoid, 41 or 42 in lateral line.

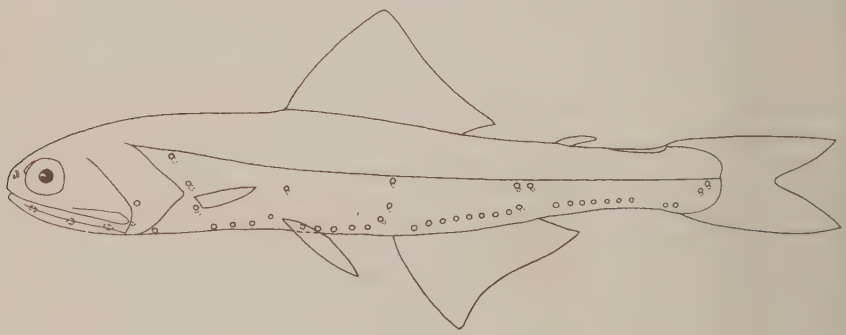

Fig. 29. *Notoscopelus elongatus* (Costa).

Measurements in percent of standard length based on 2 specimens 110.0 and 113.5 mm. in standard length: length of head 26.4 (26.3-26.6); diameter of orbit 6.0 (5.8-6.1); length of maxillary 19.2 (18.9-19.5); distance from dorsal to ventral 14.8 (14.1-15.6); distance from dorsal to anal 24.4 (23.6-25.1); depth of caudal peduncle 8.3 (7.6-9.0); distance from snout to dorsal 40.8 (39.3-42.3); length of dorsal base 26.7 (26.6-26.8); distance from snout to anal 58.0 (57.4-58.7); length of anal base 21.0 (21.0-21.1); distance from snout to adipose 81.2 (78.6-83.7); distance from snout to pectoral 27.6 (27.3-27.8); distance from snout to ventral 41.4 (41.3-41.4).

A well developed, elongate Dn. Op_1 small, poorly developed and deeply embedded, a little below and behind end of maxillary; Op_2 about on level on upper

nd of pectoral base, very slightly behind Op_1. PLO well in advance of PVO_2, lmost in contact with lateral line. PVO_1 at base of lower pectoral rays; PVO_2 ell above pectoral base, a little closer to PVO_1 than to PLO and almost on a ine connecting these 2 organs. Five PO (6 on one side of one specimen); first nterspace much enlarged, the others about equal to each other or the last in- erspace slightly enlarged; PO_1 on a vertical about midway between Op_2 and PLO; O_2 well behind pectoral base; from ventral view the first 4 organs form slight- y diverging straight lines; PO_5 more abruptly divergent, located directly in ront of outer ventral ray. VLO about over base of outer ventral ray, markedly earer lateral line than ventral base. Five VO, about evenly spaced and forming arallel straight lines from ventral view; VO_1 slightly postero-mesad to base of nner ventral ray. SAO weakly angulated; SAO_1 a little above and behind VO_5, AO_2 about over anus, somewhat closer to SAO_1 than to SAO_3, which is about on he same vertical and in contact with lateral line. AO 9 + 7 (6-7); AOa_1 slight- y depressed; last AOa slightly elevated; AOp_1 well behind end of anal base, eparated from last AOa by an interspace 0.5 or 0.6 depth of caudal peduncle. wo Pol in a horizontal series, close to lateral line; Pol_1 about over or even omewhat in advance of last AOa. Four Prc, in 2 distinct groups; Prc_1 and Prc_2 lose together, near ventral body margin; separated from last AOp by an inter- pace about 0.8 or 0.9 as wide as that between last AOa and AOp_1; Prc_3 and Prc_4 idely separated from and well behind the first 2, near lateral line, close to- ether in an ascending series. The luminous glands of this species seem to be uite variable. My specimens have 3-6 well defined supracaudal luminous glands xtending from the fifth or sixth AOp almost to Prc_1. Small but well developed lands occur immediately below the PLO, PVO, VLO, SAO, last AOa, Pol and last 2 rc photophores. Numerous small luminous patches scattered over the entire body ndicate that in well preserved specimens a small gland may characterize most of he scales.

Color in alcohol a very dark brown, the pigment extending over all of the ins.

I have examined only 2 specimens of this species from the Misaki Sea, apan. It appears to be a very widely distributed but rather rare form, being nown from the Mediterranean Sea, from the Atlantic Ocean, at several stations etween Norway and Greenland on the north and the Cape of Good Hope on the south, nd from Japan and southern California in the Pacific.

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HESPEROMYRUS FRYI, A NEW GENUS AND SPECIES OF ECHELID EELS FROM CALIFORNIA

By George S. Myers and Margaret H. Storey

The fish described below was turned over to us by Mr. Donald L. Fry of the California State Fisheries Laboratory, to whom thanks are due for the presentation of the unique specimen to Stanford University. In attempting its identification, it has become apparent that the present classification of the Congrid, Echelid, and Ophichthyid eels is in the utmost confusion, even in regard to the supposed family distinctions. The latest definition of these groups (Trewavas, Proc. Zool. Soc. London, 1932, p. 657) is still based entirely on the position of the nostrils and the presence or absence of a fringe of fin around the caudal end, characters in which there is so much interspecific and intergeneric varia-

ion that we seriously doubt their major importance as hitherto defined. The osence of the caudal fringe in undoubted Ophichthyids is certainly correlated th their habit of digging burrows with the hard, sharp tail-tip, but in certain her forms with a less sharp tail it seems possible that the presence or absence a minuscule caudal fringe may be due to method or length of preservation. ether or not this fringe (if not due to preservation) is in all instances of al phylogenetic importance is at least questionable. The typical Ophichthyids em usually to be distinguished by a pointed snout and long, straight gape, oducing a very characteristic physiognomy which probably has a real morpho-gical basis; but eels with this physiognomy are often currently referred to helid genera (the other species of which differ widely in their broad and unded snouts) on the basis of a tiny caudal fringe (e.g., by Weber and de Beau-rt). Parr (Copeia, 1930, no. 3, p. 71) has demonstrated a peculiar apparatus, ich he calls jugostegalia, in Echelids; but we find it also in Ophichthyids *Ascanichthys, Mystriophis)* as well as in our new form. Whether or not the pparatus is present in any of the supposed Congrids is not yet known.

Faced with what we believe to be a necessary entire realignment or re-lassification of these three families based on sound anatomical study of all the ncluded genera, we can at the moment do no more than to accept the Echelidae as sually defined, and place our new fish in this group, even though it is possible at this family may have to be merged with the Ophichthyidae.

Nine genera of Echelidae might be recognized: *Echelus* Rafinesque 1810, *yrophis* Lütken 1851, *Chilorhinus* Lütken 1851, *Muraenichthys* Bleeker 1853, *Para-yrus* Günther 1870, *Hoplopterura* Cope 1871, *Ahlia* Jordan and Davis 1892, *Myrop-yrura* Ogilby 1897, and *Arenichthys* Beebe and Tee-Van 1938. *Garmanichthys* Seale 917, *Chrinorhinus* Howell Rivero 1932, and *Merinthichthys* Howell Rivero 1934 are robably not members of this group. *Bathymyrus* Alcock 1890 is apparently a ongrid (perhaps a teratological, "pug-nosed" example), and *Sinomyrus* Lin 1933 is Dyssomid.

Hesperomyrus fryi, new genus and species

Holotype: Stanford Natural History Museum no. 25251, taken near the break-ater, San Pedro, California, with a dip-net at night under a spot-light, August 7, 1930, by Donald L. Fry and Lionel A. Walford.

The only genus with which *Hesperomyrus* might be confused is *Myrophis* Lüt-en 1851. The differences, though real, are in some cases difficult to define, specially since the latter genus is so urgently in need of revision. The differ-nces include the dentition, the size and shape of the snout, the height and haracter of the vertical fins, the character of the pectoral fins, and the ro-ust, almost cylindrical body.

Body robust for an Echelid, nearly round in cross section; similar in ppearance to *Myrichthys*. Head large, a little deeper but no wider than the runk, which shows little decrease in depth from gill-opening to anus. Tail long, lmost 1⅓ times trunk plus head, only the posterior part much compressed. Snout ithout a spiny boss, conical and pointed, somewhat like *Sphagebranchus*. No ilaments on snout or lips, but as usual with these eels, there are fine villi-orm hairs over much of the head, including the lips. Lower jaw shorter than pper. Anterior nostrils tubular, on edge of snout, directed downward, above tip f lower jaw; posterior nostrils each concealed beneath a large, backwardly irected flap on edge of upper lip, below anterior margin of eye. Gape moderate,

reaching about half the eye diameter behind eye, which is moderate. No greatly enlarged or canine-like teeth. All but the premaxillary teeth are acute, more or less recurved. Premaxillary teeth, notably small, low, and blunt, but not granular, in an irregular double series; vomerine teeth slightly enlarged and in two irregular series anteriorly, much smaller and irregularly uniserial posteriorly; upper jaw teeth almost entirely uniserial anteriorly, but with some irregular biseriality on one side posteriorly. Teeth in lower jaw slightly enlarged and in two irregular series anteriorly, uniserial posteriorly. Gill-opening, with angle of 75° (Storey, Stanford Ichthyol. Bull., vol. 1, no. 3, 1939, p. 62), of moderate depth, about equal to eye, and about one third width of isthmus. Pectoral fins present, fleshy, short and rounded, but well developed, much like those of certain species of *Anguilla*. Dorsal fin rather low until over half a head length before end of tail, where it broadens out to form a wide fin, meeting the anal around end of tail; this pseudo-cæudal is broadly rounded terminally. For most of its length the anal is notably higher than the dorsal fin; neither is fleshy, the rays are easily seen through the thin membrane.

Ground color tan, darker posteriorly; vertical fins pale, pectoral as dark as posterior part of body. Under a dissecting glass the head (top, snout, cheeks,

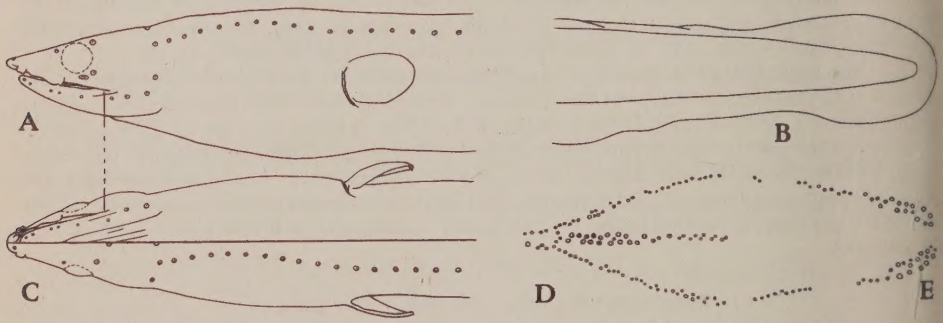

Fig. 1. *Hesperomyrus fryi*, holotype. A. Profile of head. B. End of tail. C. Lower and upper aspects of head. D. Upper teeth. E. Lower teeth.

jaws) and dorsum and sides of body appear thinly covered with fine, blackish punctulations, more scattered laterally. Vertical fins with similar scattered punctulations, except on outer margins, which are plain, as are the pectorals.

Measurements of holotype in mm: length to tail-tip, excluding fin-rays, 372.6; posteriormost rays (slightly damaged) 2.7; depth (middle of body) 15.0; width (middle of body) 13.0; head (snout-tip to distal or lower margin of gill-opening) 39.6; trunk 112.0; tail 221.0; snout-tip to dorsal fin origin 87.5; snout-tip to inner rictus of jaw 11.0; lower jaw tip to inner rictus 9.6; snout 6.5; snout width at anterior nostrils 2.7; snout width just anterior to eye 6.0; interorbital width 5.2; eye (horizontal diameter) 3.5; width of pectoral base 4.3; length of pectoral, right, 6.8, left, 6.6; breadth of pectoral, right, 6.5; left, 5.0; depth (height) of gill-opening, right, 3.1, left, 4.0; isthmus 9.6; gill-opening angle (left) 75°; dorsal height near middle of fin 4.0; anal height near middle of fin 6.0. Measurements taken in March, 1939.

If we are to follow Parr's lead (Bull. Bingham Oceanog. Coll., vol. 3, art. 4, 1930, p. 8) in ignoring as generically significant the position and arrangement of the teeth and the position of the origin of a well developed dorsal fin, we should have to synonymize not only *Ahlia* with *Myrophis* (as he has

one) but also both of these, plus *Paramyrus* and *Hesperomyrus*, with *Echelus*! e are not yet willing to accept such a radical step. In view of Parr's sugges- ion that the type of *Ahlia* (15 inches long) may have lost its vomerine teeth uring growth, it is interesting to note that the 150-mm. example recorded by ilbert (Proc. Washington Acad. Sci., vol. 2, 1900, p. 163), which we believe to e referable to the genus *Ahlia*, has uniserial maxillary and no vomerine teeth. *yrophis* has maxillary and vomerine teeth in bands.

A NEW CYPRINID FISH OF THE GENUS *MICRORASBORA* FROM LOWER BURMA

By Albert W. C. T. Herre

Microrasbora gatesi, new species

Dorsal III,5 or 6 (by exception II,7); anal III,12 or 13; pectoral I,10; entral I,6. None of the rays are bony, but I have indicated the branched and un- ranched ones in the formulae. Scales in a longitudinal series 26 to 28, plus 1 r 2 on the caudal base; 7 or 7½ in transverse series; predorsal 12, rarely 11 or 13?). No trace of a lateral line is visible. Anal fin with a distinct basal heath of one row of scales. Depth 3.75-4.0, head 3.75-4.1, the deeply forked audal 2.9-3.14 times in standard length. Eye 2.35-2.5 times in head; the short, luntly rounded snout is 1.75-2.0 times in eye, or 4.4-4.8 in head; the rounded nterorbital is 1.46-1.56 in eye, or about 3.6 in head. Least depth of caudal eduncle 2.1-2.2 in head. Body laterally compressed, highest at dorsal origin, loping gradually to snout. Scales thin and very deciduous, most of the specimens aving few remaining. Dorsal origin above or slightly before anal origin, dis- inctly nearer caudal base than snout-tip; predorsal length 54.5% and distance ehind dorsal origin 45.5% of total length. Tip of pectoral fin may reach origin f ventral, or may fall short of it; ventrals not quite reaching vent. Color in lcohol very pale yellowish; postorbital plate on top of head dusky, with many lackish brown dots; a few similar dots sparingly sprinkled on interorbital and nout. A line of minute black dots along the median line of the back, from head o tail; a line of black dots begins above tip of pectoral and runs back along edian line to middle of caudal base; a row of black dots on the anal base; a imilar row lies a short distance above anal and runs backward to middle of under ide of caudal peduncle, where it meets its fellow from the other side and con- inues on to caudal base. Dorsal spines speckled with minute black dots; fins therwise colorless.

This tiny fish bears no very close relationship or resemblance to three of he four species referred by Annandale (Rec. Indian Mus., vol. 14, 1918, p. 50) o his new genus *Microrasbora*, but it is very similar in form, appearance, and he pattern of dark markings, to the genotype, *M. rubescens*, from the Inlé Lake. owever, Dr. Myers has extracted and prepared the pharyngeal teeth of one of my legu specimens and finds them to be in two definite, regular rows (5,3), thus iffering trenchantly from the numerous, irregularly placed, three-rowed teeth of *ubescens*.

Holotype: Stanford Natural History Museum no. 33897, 23 mm. standard ength, collected by the writer from a pond near Judson College, Rangoon, in 937. There are 16 paratypes (no. 33898), 16-22 mm. long, from the type locality,

and 14 others (no. 33899), 20.5-23 mm. long, taken from a creek 9 miles northwest of Hlegu, Burma.

I take pleasure in naming this little fish in honor of Dr. Gordon E. Gates the distinguished lumbricologist of Judson College, without whose aid my visit to Rangoon would have been of little avail.

THE POSSIBLE IDENTITY OF THE CONGO FISH *TELEOGRAMMA* WITH THE CICHLID GENUS *LEPTOLAMPROLOGUS*

By George S. Myers

In 1927 (Revue Zool. Africaine, vol. 15, fasc. 1, p. 55), Prof. Pellegrin described a new genus and species of Cichlidae, *Leptolamprologus monogramma*, from Tshikapa, Kasai River, Belgian Congo. Two later accounts of the fish have been published by Pellegrin (Bull. Soc. Zool. France, vol. 53, 1928, p. 111; Annales Musée Congo Belge, Zool., ser. 1, vol. 3, fasc. 1, 1928, p. 34, fig. 23) in which the species is recorded from Luluabourg. In 1934 (Amer. Mus. Novit., no. 723, pp. 5-6), Nichols and La Monte gave notes on other specimens from Luluabourg.

It seems to me that *Leptolamprologus* needs comparison with *Teleogramma gracile*, an almost forgotten fish described by Boulenger in 1899 (Annales Musée Congo, Zool., ser. 1, vol. 1, fasc. 3, p. 53, pl. 28, fig. 2) from a single specimen obtained at Matadi, near the mouth of the Congo. Boulenger described *Teleogramma* as a new genus of Labridae, and supposed that his specimen represented the young of a marine fish that had penetrated far into the Congo estuary. Evidently for this reason, he did not include the genus in his "Catalogue of the fresh-water fishes of Africa," but no Labrid agreeing with *Teleogramma* has been found on the West African coast despite a considerable amount of subsequent work (see Fowler, Marine fishes of West Africa, 1936). From Boulenger's figure, *Teleogramma* seems to have single nostrils, and I believe it is a Cichlid.

From the descriptions, I can see no fundamental generic differences between *Teleogramma* and *Leptolamprologus*. Combining the counts and proportions given by Pellegrin and by Nichols and La Monte for *L. monogramma*, and comparing these with Boulenger's figures for *T. gracile*, we arrive at the following result (figures for *Teleogramma* in parentheses): Dorsal XX,9-11 (XX,8); anal IV,8-10 (V,6); lateral line 34-37 (37); transverse scales 8-10/13-16 (10/20); depth in length 5.5-6.6 (6); head in length 3.0-3.8 (4); eye in head "about 3"-4.6 (5.5). In so far as the descriptions are comparable, the chief differences seem to lie in the anal count, the size of the eye, and (from the illustrations) the proportions of the caudal peduncle. Several of the apparent differences may be due solely to the method of counting or measuring, or to slight errors in Boulenger's description, which was drawn up from a single specimen perhaps not in the best of condition. A critical comparison of the types in the Musée du Congo Belge at Tervueren is evidently in order.

Parenthetically, it may be noted that *Euchilichthys boulengeri* and *Steatocranus elongatus*, described by Nichols and La Monte in 1934 (num. cit. supra) from Luluabourg, should be critically compared with *Atopochilus astatodon* and *Leptotilapia rouxi*, two species described from exactly the same locality by Pellegrin in 1928 (Revue Suisse Zool., vol. 35, pp. 295 and 300).

Obtainable from the Director of the Natural History Museum, price $1.00. Inquiries in regard to exchange should be addressed to the Editor of the Stanford Ichthyological Bulletin, Natural History Museum, Stanford University, California, U.S.A.